MAP OF CALIFORNIA &c.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 172.

B. T. GALLOWAY, *Chief of Bureau.*

GRAPE INVESTIGATIONS IN THE VINIFERA REGIONS OF THE UNITED STATES WITH REFERENCE TO RESISTANT STOCKS, DIRECT PRODUCERS, AND VINIFERAS.

BY

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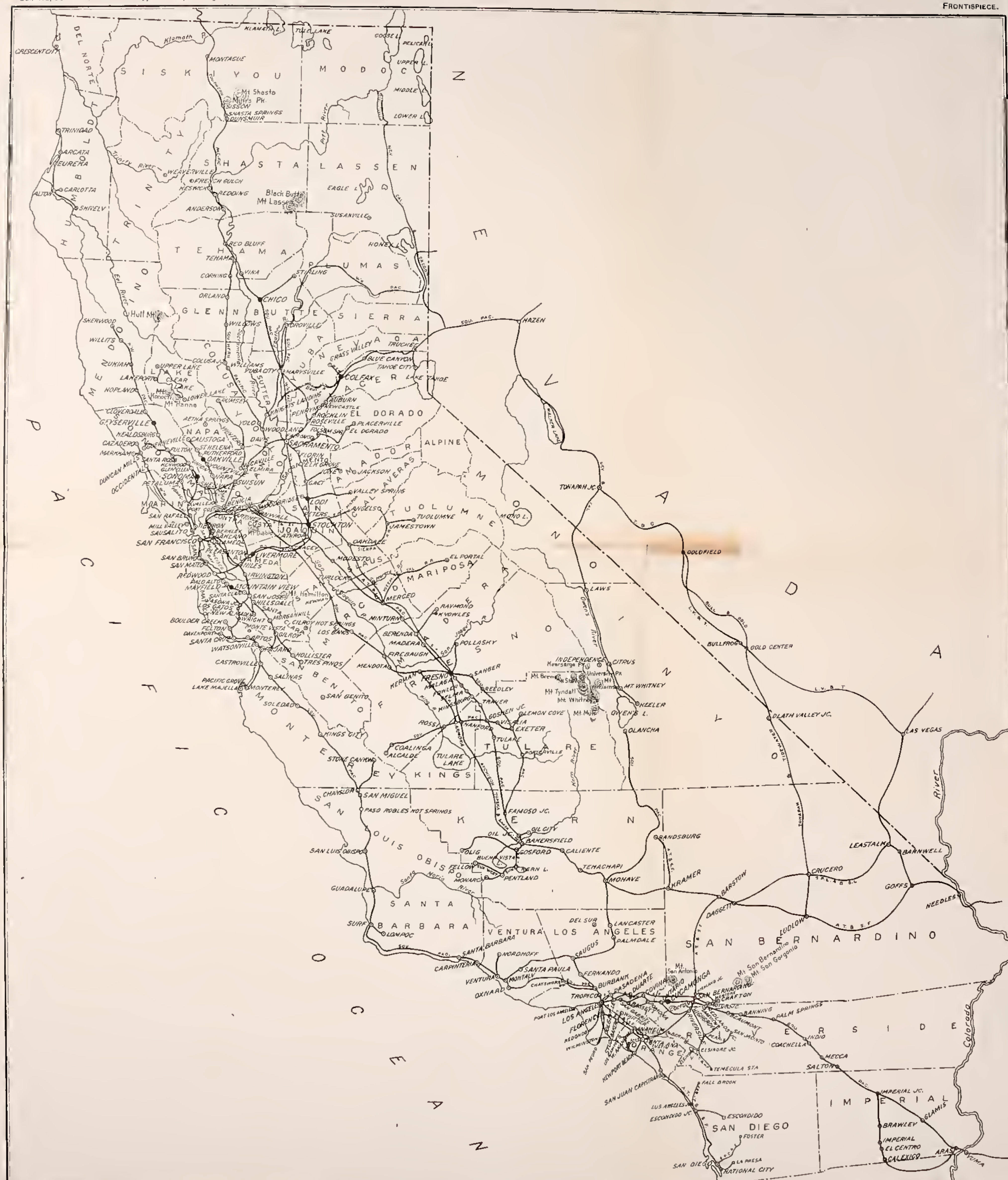

MAP OF CALIFORNIA—THE LARGER BLACK DOTS SHOWING THE LOCATION OF THE ELEVEN EXPERIMENT VINEYARDS OF THE BUREAU OF PLANT INDUSTRY.

THE NORRIS PETERS CO., WASHINGTON, D.C.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., December 8, 1909.

Sir: I have the honor to transmit herewith a manuscript entitled "Grape Investigations in the Vinifera Regions of the United States, with Reference to Resistant Stocks, Direct Producers, and Viniferas," and to recommend that it be published as Bulletin No. 172 of the series of this Bureau. This bulletin has been prepared by Mr. George C. Husmann, Pomologist in Charge of Viticultural Investigations, and was submitted by Mr. William A. Taylor, Pomologist in Charge of Field Investigations, with a view to its publication.

This bulletin summarizes the condition of the California viticultural industry in 1902 at the time when the investigations upon which it reports were begun, and it is of the nature of a preliminary report upon the phases of the viticultural investigations of this Bureau which are mentioned in the title. While most of the field work upon which this bulletin is based has been done in the State of California, the results are considered applicable to other portions of the United States where the varieties of *Vitis vinifera* are grown in the open air.

The results of the work reported upon are believed to be of distinct importance to the Vinifera grape industry through the direct bearing that they have upon the reestablishing of vineyards that have been damaged or destroyed by phylloxera as well as upon the planting of new vineyards throughout the Vinifera regions.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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EXTENT OF THE VITICULTURAL INDUSTRY OF CALIFORNIA.

During the vintage season of 1902 a careful survey of the Pacific slope grape districts was made by the writer for the Bureau of Plant Industry, to determine the conditions existing there. As nearly as could be ascertained from the most reliable data obtainable the California viticultural industry represented the following investments:

The wine industry, including vineyards, cellars, distilleries, cooperage, machinery, and capital required to carry on the business, represented an estimated investment of $72,000,000, giving employment to nearly 60,000 persons. The average output during the previous ten years had been 21,158,359 gallons of wine and 2,094,978 gallons of brandy per annum.

The investment in raisin vineyards, at a conservative estimate, amounted to $13,000,000. The average production during the previous ten years had been 91,883,860 pounds of raisins annually.

From 1894 to 1902, 7,227 carloads, or 144,540,000 pounds, of fresh grapes were shipped. The fresh-grape shipments, the smallest commercial output from the vine, constituted one-seventh of the entire eastward movement of deciduous green fruits.

The vineyards in California consisted, in 1902, of about 22,000 acres in table grapes, 90,000 acres in raisin grapes, and 120,000 acres in wine grapes, or a total of 225,000 acres. The total investment of the viticultural industry in the State at that time, at a conservative estimate, represented about $100,000,000.

THE CALIFORNIA VINE DISEASE.

The phylloxera and the California vine disease have been the two leading agencies (see Pl. I) in the destruction of vineyards in California.

The first record of the California vine disease was published in the Anaheim Gazette in 1885–86, although some claim to have noticed

effects of the disease as early as 1882. The spread of this disease was very rapid from Anaheim as a center, for which reason it is also sometimes called the Anaheim disease. In 1888 the California State Viticultural Commission appointed Mr. Ethelbert Dowlen a special agent to investigate it, and several years were devoted to it by him. Special investigations of the disease were made by Mr. Newton B. Pierce, of the United States Department of Agriculture, and reports on the same published, but in spite of very able and earnest work by him and other scientists of this and other countries, the cause and the control of the so-called California (or Anaheim) vine disease continue to baffle science.

Another survey was made by the writer during the vintage season of 1903. The conclusions reached were that careful, comprehensive, and systematic investigations of existing difficulties were needed immediately to save the industry from destruction. In southern California from 25,000 to 30,000 acres of vines had been laid waste (see Pl. I), and the entire vineyard acreage of Napa and Sonoma valleys had been once destroyed, while a portion of the second plantings had also been destroyed. In the Santa Clara Valley, where four years previously there had been produced about 6,000,000 gallons of wine, the crop of 1903 amounted to only about 500,000 gallons. The vineyards of that valley were practically gone. In other bay counties similar conditions were becoming evident. The magnitude and rapidity of the damage were appalling. Conservative calculations showed that the loss due to the destruction of vines in California was at least $1,000 a day (see Pl. I). Considering that the entire Pacific slope was interested and that California alone has an area adapted to grapes equal to almost the whole of France, which was then producing about 1,500,000,000 gallons of wine annually, the magnitude of the interests involved and the importance of aiding the industry, which is yet in its infancy, were apparent. As various means suggested by scientific and practical men had been tried and large sums had been expended to safeguard the vineyards, with little beneficial result, it was evident that a comprehensive experimental investigation of the entire subject was necessary.

PHYLLOXERA IN CALIFORNIA AND IN EUROPE.

The phylloxera, which is not native in California, was introduced into that State either from east of the Rocky Mountains, where it is indigenous on wild vines, or from Europe, or possibly from both sources. In 1880 it was found to exist in Sonoma, Napa, Solano, Yolo, Placer, and Eldorado counties. No careful investigation had been made at that time of much of the region farther south in the

State. It probably existed in Sonoma County as early as 1873, and it is possible that it occurred in the Sonoma Valley and on the Orleans Hills at least twenty years before that time.

The insect was probably introduced into Europe on American vines and taken there about 1858 to 1862, when the destruction of the French vines from oidium was feared. From that period until 1885 it became widely scattered throughout Germany, Switzerland, Austria, Hungary, Italy, Russia, Turkey, and Australia.

Innumerable remedies have been suggested and tried to eradicate the phylloxera from vineyards, but it is conceded that the only way to successfully combat it is to reestablish the vineyards on resistant stock, except in the case of vineyards which can be flooded cheaply and sufficiently to kill the insects. The Bureau of Entomology is cooperating with the Bureau of Plant Industry on the entomological phases involved in the determination of the relative resistance of stock varieties.

EARLY ATTEMPTS AT THE RECONSTRUCTION OF VINEYARDS.

The varying soil (see Pls. II and III) and climatic conditions in California have proved a great stumbling block in the reestablishment of the vineyards on resistant stocks. As early as 1876 introductions and plantings of resistant vines were made by some of the more intelligent grape growers. In the winter of 1880–81 several large orders were placed for resistant vine cuttings from east of the Rockies (some of the more important being orders through Mr. Charles A. Wetmore, the chief executive viticultural officer of the California State Viticultural Commission), for various parties, and an order to Prof. George Husmann, then of Columbia, Mo., by Mr. James W. Simonton for 120,000 resistant cuttings of the most promising species, to be placed in his vineyard near Napa, Napa County, Cal., under the direct supervision of Professor Husmann.

Some of the earliest introducers were from the start fortunate in getting resistant varieties well-adapted to their locations and soils. For instance, Messrs. Dresel and Gundlach, near Sonoma, in 1876 introduced the Lenoir and the Herbemont from Texas and selected Riparias and other resistants from Missouri. Early in their experiments they dropped the other varieties in favor of the Riparia (see Pl. II, fig. 2), it showing remarkable adaptability to their soil and climatic conditions, while the congeniality of the Riparia to the Riesling and Chasselas varieties, which they principally grew, was good. The Stanley vineyard, at the lower end of Napa Valley, was another example of success with the Riparia. As a result, when such instances as these were noted, Riparias as a stock were planted indis-

criminately in high and low localities and on various soils, particularly in the Sonoma and Napa valleys, the vineyards of which were the first destroyed by the phylloxera. Unfortunately, in most instances the soil and other conditions were not suited to the Riparia and failures predominated.

Then, again, it was claimed that the native grape *Vitis californica* was resistant. Without any substantiation of this, by 1883 at least 300,000 of these vines had been planted as grafting stocks. Later their resistance was found to be even less than that of the Labrusca.

The first authenticated report of the susceptibility of *Vitis californica* was made in 1887, when a committee consisting of Messrs. Charles Krug, H. W. Crabb, and J. H. Wheeler, appointed by the California State Viticultural Commission to investigate and report on the so-called mercurial treatment to prevent phylloxera injury, which was being tried on Mr. Henry Hagan's place, 1 mile east of Napa, discovered phylloxera on a wild vine of *V. californica.*

A few years later it was found that the Lenoir variety did remarkably well on some soils, and all who could secure them planted the Lenoir. Had more vines been available more would have been planted.

Of late years the Rupestris St. George is being as indiscriminately used, and similar mistakes have been and are being made with it.

All of the resistants mentioned and others are good under conditions and soils (see Pl. II) suited to them, but are less valuable or even worthless where they are not.

A number of experiments have been made by growers in different parts of the State. Besides the persons heretofore alluded to are Messrs. T. S. Glaister, J. H. Drummond, P. Masson, E. W. Hilgard, J. Swett, C. H. Wente, F. Devaux, C. J. Wetmore, J. Concannon, Behringer Brothers, J. Weinberger, E. Zange, J. Groezinger, J. T. Doyle, William Pierce, and a number of others.

Introductions and distributions of some of the better known resistant varieties, most notably those selected in Europe by Mr. A. P. Hayne, have been made by the California experiment station. Plots of these have been set out, some propagating and bench-grafting experiments have been prosecuted, and a number of bulletins[a] issued on these subjects by the California station.

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[a] Resistant Vines, Their Selection, Adaptation, and Grafting. Appendix to Viticultural Report of the California Agricultural Experiment Station for 1896. 1897.

Bioletti, F. T., and del Piaz, A. M. Bench Grafting Resistant Vines. Bulletin 127, California Agricultural Experiment Station. 1900.

Bioletti, F. T. Phylloxera of the Vine. Bulletin 131, California Agricultural Experiment Station. 1901.

Bioletti, F. T., and Twight, E. H. Report on Conditions of Vineyards in Portions

FACTORS IN RESISTANCE.

The resistance of vines depends upon (1) the inherent resistant character of the vine and (2) its adaptation to soil, climatic, and other conditions.

INHERENT CHARACTER OF THE VINE.

Millardet [a] states that "the intrinsic or inherent causes are allied to the very nature of the plant, which is the cause of its being more or less attacked by the phylloxera; of the punctures of that insect producing swellings, nodosities, and tuberosities more or less numerous upon roots of different degrees of strength; the cause also of these swellings rotting more or less easily, more or less deeply, and by that rot determining more or less rapidly the enfeeblement of the roots upon which they are situated, and consequently at last the death of the vine."

Vines upon the roots of which the phylloxera does not remain and produces no injuries at all are said to be immune. The phylloxera usually first punctures the ends of the youngest roots near the extremities and fixes itself there. In a short time the swelling or nodosity appears at the puncture. This is the mildest form of the insect injury to the root of the vine that is noticeable.

The nodosity is whitish or pinkish and when seen under the microscope resembles somewhat the head and neck of a long-billed bird, and the insect causing it is as a rule found on the throat or the angle formed where the head joins the neck. The nodosities rot more or less rapidly in the different grape varieties, and in the Vinifera they usually rot in a very short time. In the American varieties the nodosities remain sound for a longer time, the various species differing in this respect. The size of the nodosities on the different species of

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of Santa Clara Valley. Bulletin 134, California Agricultural Experiment Station. 1901.

Twight, E. H. New Methods of Grafting and Budding Vines. Bulletin 146, California Agricultural Experiment Station. 1902.

Twight, E. H. Resistant Vines and Their Hybrids. Bulletin 148, California Agricultural Experiment Station. 1903.

Butler, O. Observations on Some Vine Diseases in Sonoma County. Bulletin 168, California Agricultural Experiment Station. 1905.

Bioletti, F. T. Resistant Vineyards. Bulletin 180, California Agricultural Experiment Station. 1906.

Bioletti, F. T. Grape Culture in California. Bulletin 197, California Agricultural Experiment Station. 1908.

Suggestions and Preparation of Vine Cuttings. Circular 26, California Agricultural Experiment Station. 1908.

[a] Quoted from "New Researches upon the Resistance of and the Exemption from Phylloxera," by A. Millardet, in Report of the California State Viticultural Commission for 1891–92.

grapes also varies very much, those on the Vinifera being about three times as large as those on the most resistant American species. Between these extremes may be found all intermediate sizes.

The number of nodosities varies greatly on the different vine varieties, and after the formation of a considerable number of nodosities upon the rootlets the insects, having multiplied gradually, eventually attack the relatively larger roots, and if cancerous patches of decomposition are found on the more developed roots something more serious is threatened—namely, a tuberosity. Whenever tuberosities are found there are also nodosities, but the reverse is not true. On some grape varieties the nodosities may be found on practically all of the rootlets, while on others there may be practically none.

Varieties of some of the American species are not injured by the phylloxera any further than the forming of a few nodosities on their roots. Such vines have a very high resistance. In fact, on a determination of the relative number and size of nodosities found on the roots of the different species the resistant ratings of these species are based. In order to indicate with some degree of definiteness the resistance to phylloxera (not the value of the stock), viticultural scientists have provisionally adopted an arbitrary scale of ratings. In this scale the maximum of resistance or immunity is taken as 20, while absence of or no resistance is reckoned as zero. In accordance with this method, Viala and Ravaz have drawn up the following scale of resistance of different varieties: Rotundifolia, 19; Vulpina or Riparia, Rupestris, and Cordifolia, 18; Berlandieri and Monticola, 17; Rupestris St. George, 16; Cinerea, Aestivalis, and Candicans, 15; Longii and Nova Mexicana, 14; Taylor, 13; Lenoir and Herbemont, 12; Elvira, 10; Labrusca, 5; and Vinifera, 0. According to this, *Vitis rotundifolia* occupies the highest position, with 19 points, which, for all practical purposes, represents absolute resistance, whereas the Vinifera varieties show 0, or no resistance.

The necessary degree of resistance for the production of good crops varies with the character of the soil, those stocks rating above 16 being considered sufficient for all soils, 14 to 16 for fairly good soils, and 10 to 14 for rich, moist, sandy soils.

ADAPTATION TO SOIL, CLIMATE, AND OTHER CONDITIONS.

The resistance of a vine to the phylloxera, or rather its ability to withstand the attacks of the insect without serious injury, is influenced greatly by the adaptability of the vine to the climatic and soil conditions (see Pl. III) in which it is grown. These either increase or diminish the vigor of the plant and retard or favor the reparation of the insect injuries. The soil and the climate may also affect the

resistance by favoring or hindering the approach, dissemination, or activity of the insect. For instance, sand of a certain fineness is an obstacle to the insect in going from the surface of the ground to the root of the vines and from one vine to another.

Climatic variations also affect the multiplication of the insect. Then, again, a vine variety which in one locality has splendid resistant qualities perishes in another locality having the same soil but a different climate, or in another locality having the same climate but a different soil. This is due not only to the adaptability of some species to moist and others to drier soil, etc., but also to the habit of the root systems of the species (see Pl. II), which vary from horizontal to vertical, and to other characteristics of the roots, which vary from thick to thin and from soft to hard, with intermediate grades between these extremes. It will readily be seen how a horizontal root system would suffer in a dry soil and hot climate and what a punishment it would be for a deep-rooting system to be planted in a shallow, hard soil, or a moisture-loving variety where there is but little moisture, or vice versa.

The congeniality existing between vine varieties when grafted on other vine varieties also has its influence on resistance to the phylloxera. Causes like these, and there are many others, affect the resistant qualities of vines, and it is with the study of the adaptation of varieties to varying conditions and the congeniality existing between the varieties that the researches reported on here are largely concerned. A variety under congenial conditions of soil and climate will frequently prove more resistant than one which has greater natural resistance but which is not adapted to the particular conditions. Thus, the Lenoir in many localities in California on deep and loose soils (see Pl. II, fig. 4) has proved an excellent resistant and is the vine on which some investigators base the possibility of resistance to the California vine disease. This variety is not highly esteemed as a resistant in France, although it is grown there quite largely for its fruit out of which to make wine for blending purposes.

Such instances as these, together with the fact that in France much of the work of selection and breeding of resistant stocks has been largely influenced by their relative ability to endure an excess of lime, which is rarely encountered in California vineyard districts, make it plain that the resistance standards established by the French can not be accepted as infallible in America or, in fact, serve as more than general guides for American viticultural investigators and vineyardists.

The waste of money spent in the reestablishment of vineyards in California from the first appearance of the phylloxera to the present time can not even be approximately estimated. That the destruc-

tion of California vineyards has been continuous for many years is evident from the fact that the total annual yields of grapes show a relatively small increase from year to year, notwithstanding the large acreage that has been set out each year.

Some of the direct causes of these results are the planting of non-resistants; the planting of resistants not adapted to the conditions and the grafting upon them of Viniferas uncongenial to them or not suited to the local conditions; the obtaining of resistant stocks not true to name; and lack of proper care and management of resistant vineyards (see Pl. III), such as the allowing of roots to grow from Vinifera tops grafted on resistant stocks. (See Pl. V, fig. 1.)

The use of resistant stocks should have become general before now. Their use is increasing, but so little information regarding what varieties to plant has been available that many planters have taken and still are taking chances on profitable returns by planting Viniferas on virgin soils or even by replanting with them vineyards destroyed previously by the phylloxera. Through one or more of these reasons there are many comparatively young vineyards in the State that show decline.

Among some of the publications to which reference has been had and from which data relative to past experiments in this country have been taken should be mentioned the following:

Investigations and Improvement of American Grapes, 1876 to 1900, Bulletin 56, Texas Agricultural Experiment Station, 1900; and other writings of Prof. T. V. Munson.

American Grape Growing and Wine Making, 1902; Grape Culture and Wine Making in California, 1888; The Grape Culturist, 1869 to 1871, inclusive; and other writings of Prof. George Husmann.

Annual Entomological Reports of Missouri, by Prof. C. V. Riley, 1868 to 1877.

Reports of the California Viticultural Commission, 1880 to 1894.

Bushberg Catalogue of American Vines, edition 1895.

California Vine Disease, by Newton B. Pierce, 1902.

Publications on resistant-grape investigations by various authors in the different European vine countries.

Acknowledgment for data obtained from these and other sources is gratefully made.

FOREIGN DETERMINATIONS AS TO RESISTANCE INAPPLICABLE IN AMERICA.

In the portions of this country where the Vinifera varieties are commercially grown, soil, climatic, and other conditions differ so much from those of France that it is often unsafe to accept the resistant ratings given to the different varieties by French viticulturists. This is very forcibly shown by the experience with the Riparia varieties so largely used by the French in the past. These are adapted to but few grape localities of California. The French vineyards are

so largely located on limy soils that the ability of resistant stocks to endure calcareous conditions has entered much more largely into the varietal ratings than is necessary for stocks for California vineyards. The value of resistants as graft bearers depends to a considerable extent on whether the stock and the scion are both suited to the soil, climatic, and other conditions of the section where they are to be grown and whether the congeniality between them is good.

In taking up the work in California the following lines of research were undertaken.

SCOPE AND PURPOSE OF THE WORK OF THE BUREAU OF PLANT INDUSTRY.

(1) A comprehensive test of the resistant varieties of vines to determine their adaptability to the different vineyard soils and climatic conditions. (See Pls. II and III.)

FIG. 1.—One of the experiment vineyards of the Bureau of Plant Industry. A box containing a thermograph is shown in the foreground.

(2) A study of the congeniality of the Vinifera varieties to the different resistant stock varieties. (See Pl. VII.)

(3) A study of the behavior of fruiting varieties to determine which are best adapted to different localities. (See Frontispiece, Pls. II, III, and VII, and fig. 1.)

(4) A consideration of all classes of grapes with reference to their resistance to destructive insects and diseases and, if found necessary, the origination of an entirely new class of grapes better adapted to Pacific-coast conditions. (See Pls. I, II, IV, and V.)

SPECIES AND VARIETIES OF GRAPES UNDER TEST.

Of the twenty-three species of grapes native in North America the following fourteen have been found sufficiently resistant to merit the

attention of the viticulturist, and are under test in the experiment vineyards of the United States Department of Agriculture:

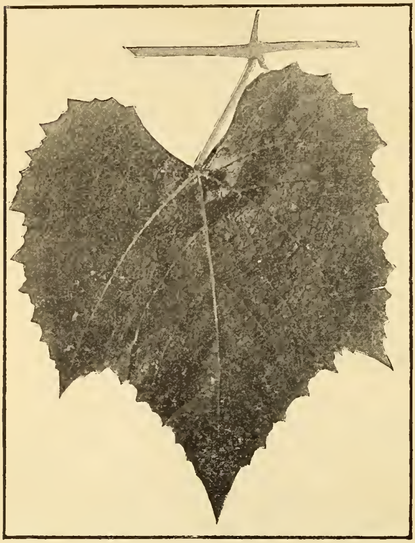

FIG. 2.—*Vitis labrusca;* upper side of Concord leaf. (One-sixth natural size.)

Vitis labrusca L. (Northern Fox grape).—Vine a vigorous, medium-sized climber; canes rugose, with numerous thick hairs; tendrils continuous, opposite each leaf, all other grape species having intermittent or discontinuous tendrils. Leaves (figs. 2 and 3) large, orbicular, entire, bright green above, covered with white or yellowish velvety tomentum underneath; petiolar sinus deep. Clusters of medium size; berries medium to above medium, covered with bloom, usually violet-black; pulp fleshy and of distinct foxy aroma. Seeds large and thick; beak short. Roots large and fleshy. Found native in the Allegheny Mountains from New England to South Carolina, principally on eastern exposures, preferring wet thickets and granitic soils. Under congenial conditions this variety thrives in the presence of the phylloxera, although its resistance is not rated higher than 5 out of a possible 20. Cuttings root easily and grafts knit well with *vinifera.* It is resistant to mildew but is sensitive to black-rot. The majority of the varieties of our native grapes cultivated for fruit in this country are either pure seedlings of this species or hybrids between it and others. It is not adapted to many California localities or soils.

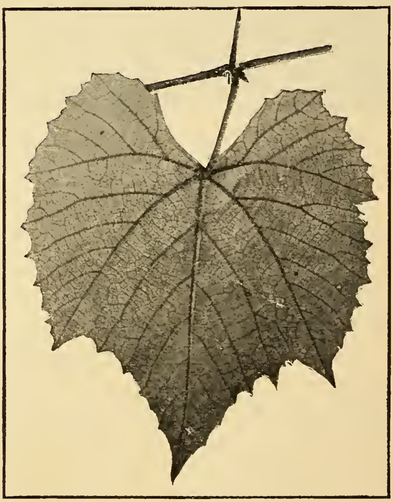

FIG. 3.—*Vitis labrusca;* lower side of Concord leaf. (One-sixth natural size.)

Vitis candicans Engelm. (Mustang grape).—Vine a moderately vigorous, medium-sized climber; canes deep brown, covered with white hair (which is generally rusty tipped) and having very thick diaphragms; tendrils discontinuous or intermittent. Young leaves covered with thick white tomentum; adult leaves (figs. 4 and 5) medium to above medium in size, cordate, rounded, flexible, entire, 3, 5, or 7 lobed, edge often inflected, thick dark green above, covered with white, thick, felty tomentum underneath; petiolar sinus shallow. Clusters small; berries medium sized, black, globular, discoid, pulpy, and of a harsh taste. Seeds large; beak short; chalaza and raphe imperfectly developed, grooved. Roots vigorous, tender, dark gray. The cuttings are exceedingly hard to root. This variety grafts well and knits easily. Starts medium early in the season. Found on the black waxy lands of Oklahoma, Indian

Territory, and Texas, and is also met with in New Mexico. Very resistant to drought, heat, and cryptogamic diseases, but not to cold, 10 degrees below zero being sufficient to kill it. Grows on clay, sour, little-fertile soil, but is much more vigorous on more fertile soils. Resistance to phylloxera rated at 15. Ravaz considers the *candicans* allied to *rupestris* and perhaps *arizonica*.

Vitis aestivalis Michx.—Vine a vigorous, medium-sized climber; canes deep-wine color, with bloom at the nodes; buds red or brown; tendrils discontinuous. Young leaves red; leaves (fig. 6) medium sized, suborbicular, entire or lobed, dark green above, with cottony, rusty down underneath; petiolar sinus deep. Clusters medium to large, rather open; berries medium sized, round, usually black, covered with bloom, juicy, with clean taste. Seeds rather small; beak short; chalaza round and prominent; raphe limited. Roots rather large, hard, and plunging. Hard to root from cuttings. Starts rather late. Grafts well. This variety occurs from southern New York to Florida, and westward to the Mississippi and Missouri rivers It delights in high, warm, sandy, gravelly, moist soil. It is rarely found in very dry soils and never in swampy lowlands, and is not adapted to calcareous soils. Resistance to phylloxera about 15. Seibel, Couderc, and Malleque used this species extensively as one of the parents in producing their hybrids.

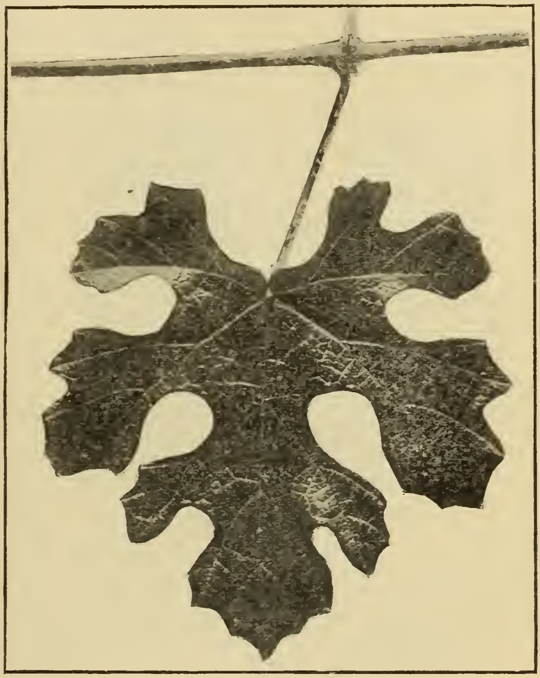

FIG. 4.—*Vitis candicans;* upper side of leaf. (Four-ninths natural size.)

Vitis linsecomii Buckley (Post-Oak, Pine-Wood, or Turkey grape).—Vine a vigorous, good-sized climber; canes dark brown; limbs thick and rugose; tendrils discontinuous. Leaves very large, deep green above, glaucous underneath, orbicular, entire or lobed with deep sinuses; petiolar sinus very deep, with tangent lips. Clusters medium; berries medium, discoid, covered with bloom and having a peculiar flavor. Seeds large, pear shaped; beak detached; chalaza orbicular, wide; raphe filiform. Roots medium sized, hard, and long. Hard to root from cuttings. Starts rather late. Found in sandy, high, well-drained timber lands of Texas, on the ridges in siliceous or granitic gravel mixed with clay, rather compact soils; also in the very deep and rich soils of river banks, but not in limy soils or black lands of low bottoms. Very resistant to heat, drought, and cold. Considered a good graft bearer. Quite a number of *linsecomii* hybrids have been grown which as direct producers of wine grapes are attracting considerable attention. There being no straight representative of the *Vitis linsecomii* in the collection of the Bureau of Plant Industry, the leaf of a hybrid is shown.

Vitis monticola Buckley (Sweet Mountain grape).—Vine rather small; canes short, ramified, tomentose, angular, violaceous green (striated and red-brown at maturity),

the young growth angled and floccose (sometimes glabrous); diaphragms plane and rather thin; stipules red, one-eighth inch. Young leaves shiny; adult leaves orbicular, entire, smooth, medium, very shining green, brittle; dentations angular, glabrous; veins red at their base above, scarce, short, pubescent underneath. Bunches small, shouldered; berries round, small, black or roseate; taste pleasant, at the same time sweet and acid. Seeds with chalaza round and raphe protruding. Roots bushy, plunging. Munson and Couderc used this variety in their hybridizations. It is found exclusively on the low limestone hills of Texas; never in very low places. It is one of the most resistant to lime soils, and also ranks high in resistance to phylloxera. Does moderately well in sandy soils. There being no straight representative of the *Vitis monticola* in the collection of the Bureau of Plant Industry, the leaf of a hybrid is shown (figs. 9 and 10).

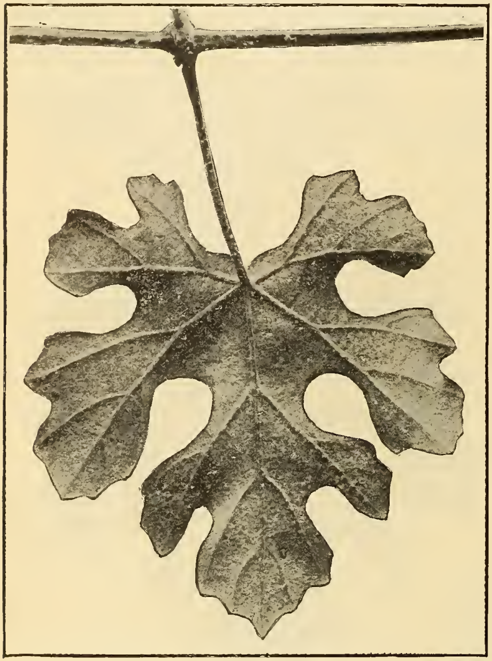

FIG. 5.—*Vitis candicans;* lower side of leaf. (Four-ninths natural size.)

Vitis berlandieri Planch (Little Mountain grape).—Vines mostly slender; canes long, slender, downy, with short internodes and rather thick diaphragms. Young leaves light green or copper colored, thickly tomentose; adult leaves (figs. 11 and 12) medium sized, cuneiform, medium, green on both sides; dentations small, rounded; upper side araneous, sometimes pubescent, rugose; under side araneous pubescent. Bunches generally small, compact, sometimes pyramidal; berries round, discoid, small, pulpy, intense black, of agreeable acid flavor. Seeds rounded, large. Roots generally strong and plunging, gray, carneous. This variety is found on the tops as well as along the sides and bottoms of the limestone hills of Texas and the northern part of Mexico. It is one of the most resistant to limy conditions, as well as one of the most resistant to drought, heat, and cold. Its resistance to phylloxera is rated at 19. Starts late; a medium to good grower. Cuttings of most varieties are exceedingly hard to root. Grafts easily and the grafts do well and are quite productive.

Vitis cordifolia Michx. (Frost or Sour Winter grape).—Vine a vigorous, strong grower of climbing habit; canes of shining cinnamon color, with base of hair persistent; nodes flat; internodes long; buds almost glabrous; tendrils discontinuous. Young leaves of a fawn-colored, varnished appearance; adult leaves thick, medium sized, cordate, elongate, entire, shining green above, more glossy, lighter green, with ribs covered with short supple hair, underneath; dentations white, petiole grooved. Clusters long, loose; berries small, spherical, shining, black, with harsh taste. Seeds medium sized; beak stout and short; chalaza round; raphe forming small ending abruptly. Roots strong, carneous, yellowish, and hard. Starts late. Rather hard to root from cuttings. This species is found with the Riparia in deep, rich, loose soils on river

banks from the Great Lakes to Florida. It is especially abundant in Illinois, Tennessee, Missouri, Arkansas, and northern Texas. A good grafting stock, grafts on it being usually strong and fruitful. Adapted to same soils as the Riparia. Resistance to phylloxera rated at 19. It being exceedingly hard to root from cuttings, crosses of it and easier rooting species are used in the resistant work. No straight *cordifolia* being used in the researches of the Bureau of Plant Industry, the leaves of hybrids are shown (figs. 13, 14, and 15).

Vitis cinerea Engelm. (Sweet Winter or Ashy grape).—Vine a vigorous and strong grower; canes long, costate, very pubescent, ashy gray; tendrils discontinuous; stipules two-eighths of an inch; buds thick, white tomentose. Young leaves thick, white tomentose; adult leaves cordate, truncate, elongated, entire, dull grayish above, dull ashy green, light tomentum underneath, tomentose, pubescent on veins; teeth wide and obtuse; petiolar sinus very deep, slightly open. Clusters rather large, loose; berries small, spherical, shiny, black, acid taste. Seeds medium sized, elongate; beak short, narrow; chalaza round and small; raphe protruding. Roots large, fleshy, gray, plunging. Hard to root from cuttings. This species is widely distributed, being found from Illinois to Texas in the same territory as the *cordifolia* and, like it, in deep, rich, loose soils on river banks; also on low, swampy clay land, and never in very loose, dry soils. Its resistance to phylloxera would probably be rated as 15. Of special value on swampy land. There being no straight *cinerea* in the collection of the Bureau of Plant Industry, the leaves of a hybrid are shown (figs. 16 and 17).

FIG. 6.—*Vitis aestivalis:* upper side of Lenoir leaf. (Two-ninths natural size.)

Vitis champini Planch (Adobe Land grape).—Vine a vigorous, spreading grower; canes very downy, violaceous, green, mahogany when ripe, finely striated, thick, spreading and ramified; stipules one-eighth inch, brown; tomentum whitish, tinted red. Young leaves whitish, cobwebby on both sides; adult leaves (figs. 18 and 19) thick, below medium in size, dark, shining green, slightly araneous above, light green, more araneous underneath; dentations rounded, very broad, very shallow. Flowers and ripens early. Berries hang on well after ripening. Roots large, ramified, plunging. This variety is easily propagated from layers, and cuttings root moderately easy. Found mostly on the limestone hills of Texas. Adapts itself well to a variety of soils and stands heat, drought, and limy conditions well. It grafts easily and the congeniality to nearly all Vinifera varieties appears good.

Vitis doaniana Munson (Texas Panhandle Large grape).—Vine rather slender; foliage rather dense, spreading; canes slender, finely striated, woolly; stipules three-sixteenths inch, brown; buds white roseate or reddish; parenchyma copper colored; tomentum reddish; young leaf whitish, very downy on both sides. Adult leaves (figs. 20 and 21) 3-lobed, truncate, medium sized, often rugose and puckered

in center; edge generally inflected; petiolar sinuses very wide, shallow, rounded; dentations acute, broad, angular; upper side woolly, whitish; underside pubescent, downy all over. Roots numerous, thick, rather running, deeply penetrating. This variety grows easily from cuttings. It was found by Prof. T. V. Munson growing over a large portion of the Panhandle of northern Texas. Its characters being always constant, he considered it a species and named it *doaniana*. It is a fairly good grower, does moderately well on sandy or limy soils, starts early, roots comparatively easy, and stands heat and drought well. Resistance to phylloxera would probably be rated about 12.

Vitis longii Prince (Solonis, Bush, or Gulch grape).—Vine a bushy, upright grower; canes long, whitish, downy, light green, spreading; buds white, abundant, tomentose. Young leaves abundantly tomentose, pubescent; adult leaves (figs. 22 and 23) large, entire, 3-lobed, araneous, pubescent, smooth, and whitish above, araneous and pubescent underneath; petiolar sinus wide, very shallow, upper lateral hardly distinct; dentations angular, very serrate. Roots large, hard, ramified, growing horizontally. This variety is found along banks in ravines of streams in the Texas Panhandle and in parts of New Mexico, Oklahoma, Kansas, and Colorado, in cretaceous and generally rich, red, sandy, often moist, always fresh, soils with the subsoil composed of white calcareous concretions. Starts early. Cuttings root fairly easy. Its resistance would probably be rated about 14.

FIG. 7.—Hybrid (Linsecomii × Labrusca × Vinifera); upper side of Husmann leaf. (One-sixth natural size.)

Vitis rupestris Scheele (Sand, Sugar, or Rock grape).—Vine a vigorous grower, short, thick, and bushy; canes from dull brown-red to shining chestnut-brown color, smooth, striated, and ramified; tendrils discontinuous, falling early; buds generally yellowish green, light tomentum. Young leaves bright russet-brown, transparent, sometimes glabrous, sometimes araneous; adult leaves (figs. 24 and 25) dark green and lustrous above, pale green and glossy underneath, glabrous, thick, brittle, entire or 3-lobed, broader than long, often folded inward along the midrib; veins level with parenchyma; indentations well formed, wide, and obtuse; petiolar sinus open and diminutive. Clusters small, loose; berries small, little or no bloom, tender skin, spherical, juicy; pulp strongly red colored, fine vinous taste. Seeds small, globular; beak thick and short; chalaza long, rather prominent; raphe elementary, merging into the chalaza. Roots long, slender or strong, fleshy, plunging. The cuttings are very easy to root. In the Rupestris the varieties are exceedingly numerous, and as it blossoms at the same time as some of the other species many hybrids with

these occur. The Rupestris is found in hilly, mountainous country from the Rio Grande in Texas running northeasterly into Indian Territory, through northwestern Arkansas southern Missouri, Kentucky, and Tennessee, and in the Cumberland range of mountains as far north as southern Pennsylvania, nearly always along gravelly banks and ravines in which there is running water only a portion of the time but moisture all the year. It is usually found in open places free from timber; grows in poor soils, is resistant to drought, cold, and heat, and starts early in the season. Is very subject to "puridie" and should under no circumstances be planted where there is stagnant water. One of the most resistant to phylloxera, rating as high as 19 out of a possible 20. It is best adapted for bench grafting; if grafted in vineyard, should be grafted young. Rupestris varieties are more or less sensitive to the action of lime in the soil. When Vinifera varieties are grafted or growing on it there is generally very little difference in the size of stock and scion, but varieties grafted on it drop the blossoms more readily and need to be pruned longer than when grafted on most other species. This species has been extensively used in hybridizing by Couderc, Ganzin, Millardet, Mallegue, Seibel, Terras, and Jurie. This species is represented in the experimental vineyards of the Bureau of Plant Industry by the following varieties: St. George, Mission, Martin, des Caussettes, Metallica, Constantia (synonym Mettallica S. A.), Othello, De Semis No. 81-2, Pillans, Ganzin, and Le Reux.

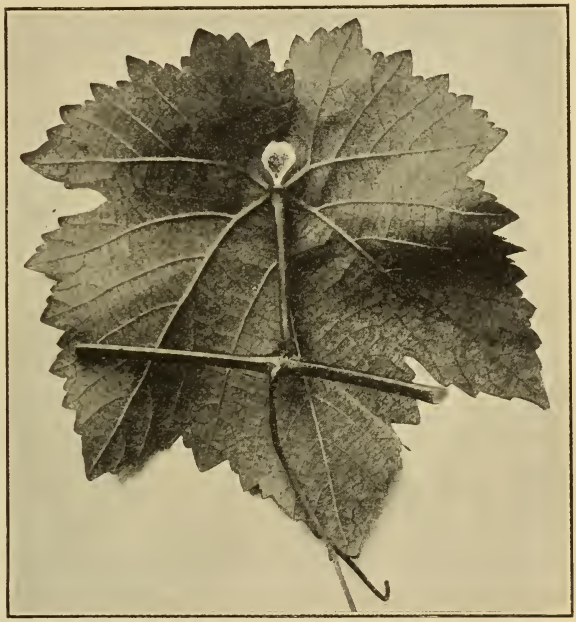

FIG. 8.—Hybrid (Linsecomii×Labrusca×Vinifera); lower side of Husmann leaf. (One-sixth natural size.)

Vitis vulpina L. (generally known as Riparia or Riverside grape).—Vine vigorous, of medium size; canes long, slender, varying in color from purple-red to ash-gray; stipules three-eighths inch, pubescent; tendrils continuous. Young leaves unfolding slowly; adult leaves (fig. 26) entire, medium to large in size, longer than broad; dentations serrate, angular, glabrous, slightly rugose above; veins red at their base; pubescence on veins underneath with aggregates of stiff hair at main angles. Clusters rather compact; berries small, spherical, dense bloom, when ripe usually black, taste agreeable, tart or neutral. Seeds very small, pear shaped. Roots long, thin, slender, hard, wiry, and very ramified, which accounts for the susceptibility of this variety to drought. Starts very early. Cuttings easy to root. Variations in this species are exceedingly numerous and, because of their long-continued inflorescence, hybrids between it and the other species are also numerous. The Riparia has the widest geographical distribution of any of the native species, being found from Salt Lake east and from Texas north in all the States as far as 90 miles north of Quebec. It is one

of the most resistant to cold and one of the most resistant to phylloxera also. It is vigorous on moist soils only and attains its best growth on sandy virgin river banks. Very few localities in California are suited to this species. It is for this reason that in the experiment vineyard there are only three pure varieties of this species, namely, Gloire de Montpellier, Grand Glabre, and France. Varieties grafted on this species nearly always bear well and ripen early, and the congeniality with most of them is good. It has in the past been very extensively used in Europe in the reestablishing of vineyards on resistant stocks, but of late years it is being replaced by more vigorous varieties and hybrids of other species, as well as by hybrids between other species and the Riparia.

Vitis bicolor Le Conte (Blue grape).—Vine a fair grower. Resembles *Vitis aestivalis* and *Vitis linsecomii.* Differs from *aestivalis* in the smaller indentations of its leaves, which are glaucous and glabrous underneath. Clusters small, compact; seeds small.

FIG. 9.—Hybrid (Riparia×Monticola, No. 18808); upper side of leaf. (Two-ninths natural size.)

FIG. 10.—Hybrid (Riparia×Monticola, No. 18808); lower side of leaf. (Two-ninths natural size.)

Very hard to root from cuttings. Starts late in the season. Found in northern Missouri, Illinois, Wisconsin, Indiana, Michigan, Ohio, Kentucky, Pennsylvania, New York, New Jersey, Maryland, and Ontario, but is especially indigenous to Michigan, Indiana, and New York. It grows well on black sandy and red siliceous soils. Very resistant to heat, drought, and cold. Resistance to phylloxera about the same as *aestivalis.* Of little practical value in reconstruction work.

Vitis simpsonii Muns., *Vitis coriacea* Shuttl., *Vitis munsoniana* Simps. Natives of Florida. Their description is omitted, as they are of little or no importance in the Pacific-coast resistant work.

Vitis arizonica Engelm., *Vitis girdiana* Muns., and *Vitis californica* Benth., not being resistant, further mention at this time is considered unnecessary.

Vitis vinifera L. (Wine grape, European grape).—Probably a native of Asia. It is illustrated (figs. 27, 28, 29, and 30) because nearly all of the varieties of grapes grown for their fruit in California are of this species. It loves a warm, dry climate, but varie-

ties thrive in nearly all well-drained soils where conditions are otherwise favorable. It is, however, not resistant to the phylloxera. Its specific characteristics can hardly be indicated, such wide variation being included in its many varieties, some of which are nearly as distinct as some of the American species, having been obtained through culture of the species for centuries under widely varying conditions.

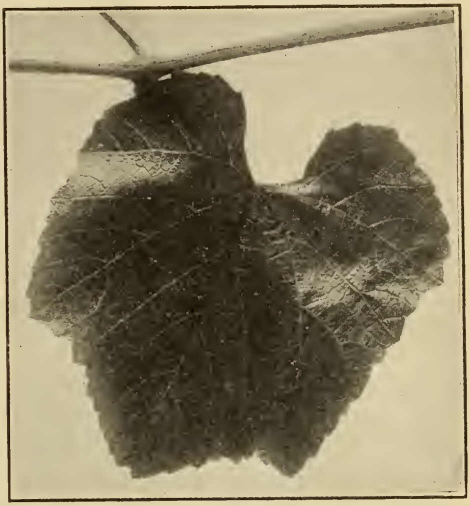

FIG. 11.— *Vitis berlandieri;* upper side of Resseguier, No. 1, leaf. (One-third natural size.)

HYBRIDS.

In the investigations of the French to get a resistant suited to their soil, climate, and other conditions which at the same time would prove a congenial, lasting, and productive stock on which to graft Vinifera varieties, many difficulties were encountered. For instance, a stock might be suited for the soil, but be so hard to root as to make its commercial use impracticable; again, the stock might be suited to the soil, root easily, and be resistant, but not be congenial to or make lasting junction with the Vinifera varieties which it was desired to graft on it; or the congeniality of the variety might otherwise be good, but the fruitfulness of the graft be impaired. Then, again, in many cases no species of resistant was exactly suited to the soil and climatic conditions. In order to overcome such difficulties and others of like nature, hybrids (see Pl. VIII) have been and are being produced, in the breeding of which such of the native American species were selected as possess the various qualities desired. In this work some remarkable successes have been

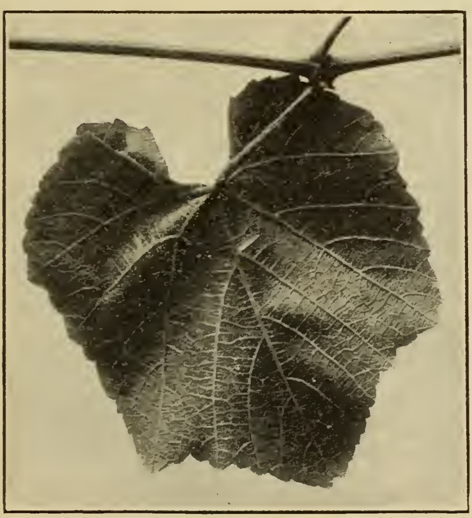

FIG. 12.— *Vitis berlandieri;* lower side of Resseguier, No. 1, leaf. (One-third natural size.)

achieved; such, for instance, as the Riparia × Rupestris, No. 3306; Riparia × Rupestris, No. 3309; Solonis × Othello, No. 1616 (hybrids grown by Couderc); Riparia × Rupestris, No. 101; Rupestris × Cordifolia, No. 107-11; Riparia × (Cordifolia × Rupestris), No. 106-8; Rupestris × Berlandieri, No. 301A; Berlandieri × Riparia, No. 420A; and Monticola × Rupestris (hybrids grown by Millardet and De Grasset). Hybrids, like those just mentioned, in which both parents are American species are termed by the French "Americo-Americans."

When we reflect on the earlier attempts at reconstruction of California vineyards on resistant stock and the many failures resulting, we can see that enormous losses and delay would have been avoided had the growers had definite knowledge before planting, and many acres of fine resistant vineyards would now be found instead of heavy mortgages.

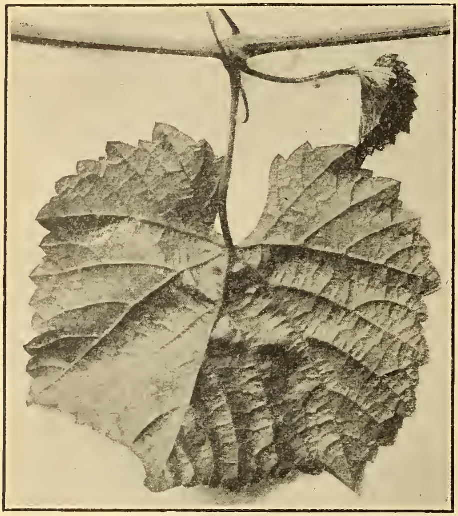

FIG. 13.—Hybrid (Rupestris × Cordifolia, No. 107-11); lower side of leaf. (One-third natural size.)

DIRECT PRODUCERS.

The French have also endeavored to produce hybrids between the Vinifera and American varieties which would be resistant to phylloxera and at the same time give sufficiently large crops of fruit of desirable character and quality. They reasoned that if such direct producers could be secured the time and cost of grafting would not only be saved, but congeniality would not have to be reckoned with. Hybrids (see Pl. IV, fig. 2) of this character are called "Franco-Americans." Some remarkable strides have been made along this line, but as yet the writer knows of no complete successes that have been obtained. Either the hybrid reverted too far toward the Vinifera and the resistant qualities were impaired, or too much toward the resistant and the quality of the fruit was undesirable, or both resistance to phylloxera and the quantity and quality of the fruit of the hybrid were not as desired.

No doubt American grape history suggested this plan of crossing to the French, for on this continent such men as Rogers and Ricketts crossed principally Labruscas with Viniferas to obtain vines that would be hardy to American conditions and in which the strong foxy flavor and aroma of the Labrusca would be avoided. Of late years

some remarkable results have been obtained in the United States by crossing productive American species. Especially is this true in red-wine varieties, many of which may prove valuable sorts in California's genial climate. A number of these hybrids are already under test in the cooperative vineyards of the Bureau of Plant Industry.

FIG. 14.—Hybrid (Cordifolia × Riparia, No. 125–1); upper side of leaf. (One-third natural size.)

When we reflect on the tremendous injury already caused to California viticulture through the California vine disease, which continues to baffle scientists and for which as yet no cure or counteracting agent has been found, it is hoped that some of these direct-producing American hybrids may prove resistant to this disease as well as to the phylloxera.

COOPERATIVE EXPERIMENT VINEYARDS ESTABLISHED AND METHODS OF WORK.

To afford opportunity for study and experimentation on the various problems involved, the Office of Field Investigations in Pomology, in conjunction with the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry, has established eleven experiment vineyards on the Pacific coast, ten of which are in cooperation with growers. A discussion of their location, purpose, and soils and of the climatic records in or near them follows, the soil descriptions and correlations being taken from a report of Mr. W. W. Mackie, Expert of the Bureau of Soils, on a soil survey made by him of the vineyards of the Bureau of Plant Industry in California. The climatological

FIG. 15.—Hybrid (Cordifolia × Riparia, No. 125–1) lower side of leaf. (One-third natural size.)

data were furnished by Prof. Alexander G. McAdie, in charge of the local office of the Weather Bureau, San Francisco, Cal.

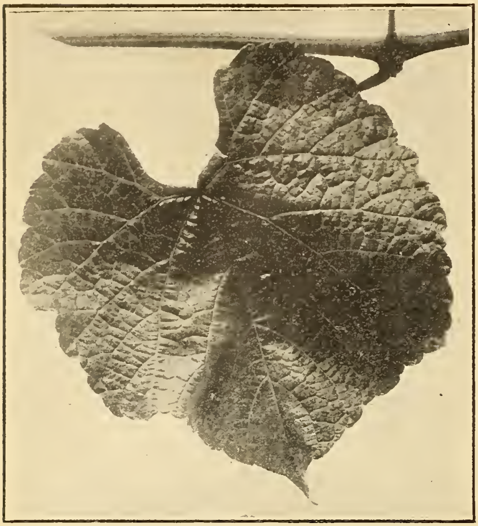

Fig. 16.—Hybrid (Rupestris × Cinerea); upper side of leaf. (Four-ninths natural size.)

It will be readily seen as the soil surveys of the viticultural areas are made to what extent and how directly the investigations in the various experiment vineyards located on diverse soil types at varying altitudes and under diverse climatic and other conditions can be made use of by the prospective grape grower.

MAIN VINEYARDS.

Three large experiment vineyards, of 20 acres each, were established at Oakville, Fresno, and Cucamonga.

OAKVILLE EXPERIMENT VINEYARD.

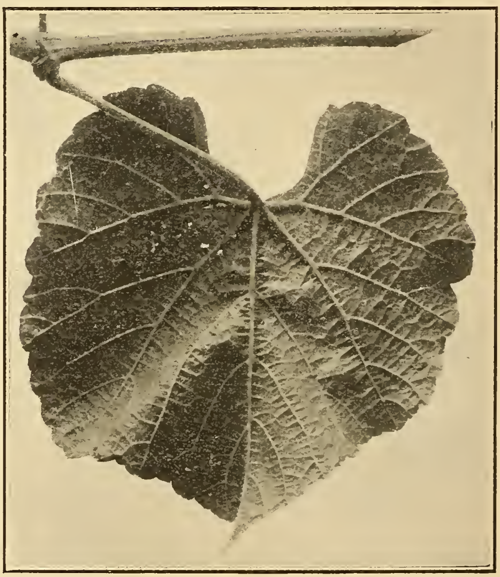

Fig. 17.—Hybrid (Rupestris × Cinerea); lower side of leaf. (Four-ninths natural size.)

The Oakville experiment vineyard is located at Oakville, Napa County, Cal., on the property of the To-Kalon Vineyard Company. It is situated 1 mile west of Oakville. The soil in the plot is a dark-brown or black gravelly clay loam or heavy loam, formed in a swamp or lagoon extending in past geological ages up Napa Valley from San Pablo Bay, and is typical of the greater part of the soils in the valley floor. The swamp conditions introduced a large quantity of organic matter into the soil, while the rains and streams washed

down large quantities of gravel from the steep hills and mountains which surrounded Napa Valley on all sides except the south. On weathering, the shales, sandstones, limestones, and lime conglomerates of the surrounding hills tend to form a heavy or clayey soil with only small quantities of sand. The gravel washed down from these soils is usually lenticular or angular, with little erosion of edges. No hardpan or alkali appears. The surface is undulating, affording a fairly rapid run-off of surplus rain water, though in places the subsoil is quite wet during the spring months. No irrigation is necessary. The quantity of clay and silt in the subsoils greatly aids in retaining moisture, in spite of the large quantity of gravel (20 to 40 per cent) they contain. This permits of cultivation to reduce to a good surface mulch clods which may have formed. Napa Valley and the foot-

FIG. 18.— *Vitis champini:* upper side of Dog Ridge leaf. (Two-thirds natural size.)

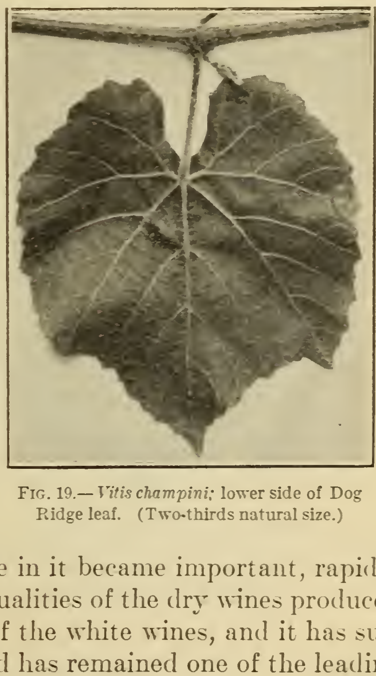

FIG. 19.— *Vitis champini;* lower side of Dog Ridge leaf. (Two-thirds natural size.)

hills adjoining it, when grape culture in it became important, rapidly made a reputation for the superior qualities of the dry wines produced there, especially for the excellence of the white wines, and it has sustained this reputation ever since, and has remained one of the leading dry-wine sections of the State.

FRESNO EXPERIMENT VINEYARD.

The Fresno experiment vineyard is located on the property of the Fresno Vineyard Company. It is about 3 miles east of Fresno, on the Sanger branch of the Southern Pacific Railroad. This plot is included in the soil survey of the Fresno area and consists entirely of San Joaquin sandy loam. This type is confined to lands adjacent to the lower foothills on the eastern side of the San Joaquin and Sacra-

mento valleys, where 75,000 acres near Fresno, 6,000 acres near Stockton, and 265,000 acres about Sacramento have already been mapped. This soil is light red in color, granitic in origin, and composed largely of sharp, angular particles. The surface is rolling, generally covered with hog wallows and small mounds. It is usually treeless, well drained, and free from alkali. The vineyard plot is an outlying isolated portion of San Joaquin sandy loam, which accounts for the increased depth to hardpan and the sandier subsoil immediately above.

In mapping this plot two varieties of soil were recognized, viz, adhesive sandy loam, closely approaching a true loam, and a friable sandy loam. The former retains moisture longer than the latter, which is a deeper soil of lighter texture. The scraping off of the hummocks in leveling the plot disturbed the natural soil conditions, increasing the depth of the sticky, adhesive sandy loam in spots and exposing free sandy loam in others, causing the hardpan underlying the plot to occur at depths of from scarcely 10 inches to over 6 feet, whereas the average depth at which it occurs is $3\frac{1}{2}$ to 4 feet below the surface. This hardpan is a red iron-sandstone substance cemented by the hydrates of iron and alumina combined with clay. When this occurs 3 feet or more below the surface of the ground, blasting is unnecessary, but when at 2 feet or less it pays to blast through it. This hardpan always accompanies the San Joaquin sandy loam soils. Trees and vines thrive when the hardpan is broken or lies at a sufficient depth below the surface.

FIG. 20.—*Vitis doaniana;* upper side of Salt Creek leaf. (One-third natural size.)

The alkali soils of the plot above the hardpan contain from less than 0.05 to more than 20 per cent of alkali; the lowest grade soils show no visible alkali. More than 90 per cent of the salts are chlorids, of which calcium forms 50, chlorid of magnesium 25, sodium chlorid 15, and potassium chlorid about 2 per cent, the remainder consisting of calcium sulphate and bicarbonate of soda. The calcium chlorid is extremely soluble and leaches more readily than any other

salt. It rises rapidly through capillary attraction, is very retentive of moisture, and often gives the soil surface where it has accumulated the dark appearance of black alkali, which was not found on the tract. The depth of the water on the tract averaged 3 feet.

Fresno is not only in the center of the raisin industry of the country, but is also one of the most important wine and brandy producing districts of the State.

In the spring of 1903 seventy resistant varieties (about 4½ acres of each) were planted in the Oakville and the Fresno experiment vineyards.

At Oakville, which is in one of the leading wine-producing districts, it is the intention to collect and test on resistant stocks such grape varieties from different parts of the world as it is thought will be of value to the Pacific slope, while at Fresno, which is in the center of the raisin district, the raisin, currant, and fleshy grape varieties are to be tested.

FIG. 21.—*Vitis doaniana:* lower side of Salt Creek leaf. (One-third natural size.)

CUCAMONGA EXPERIMENT VINEYARD.

In view of the entirely different conditions prevailing south of the Tehachapi Pass, especially in the desert region, another experimental vineyard of like importance and acreage was located at Cucamonga, Cal., on the property of the Italian Vineyard Company. This is in the San Bernardino Valley at Cucamonga, a station on the Southern Pacific Railroad. The soil is a gray-brown gravelly sand, mapped as Maricopa gravelly sand. It extends with very uniform texture to an unknown depth. The surface is quite compact when untilled, because the sharp, angular sand composing the soil becomes somewhat cemented by the organic matter usually occurring in the topsoil. Considerable small gravel is found, especially near the surface. At a depth of 3 or 4 feet there is a slightly greater concentration of silt. The color of the subsoil here is often yellowish from oxidation of the iron in the soil.

The soil is derived almost entirely from granitic wash from the Sierra Madre Mountains, and quantities of undecomposed potash feldspar particles are everywhere present in the soil. This should insure abundant potash, the element so necessary for the maturing of grapes.

FIG. 22.— *Vitis longii;* upper side of Solonis Robusta leaf. (Two-thirds natural size.)

When thoroughly cultivated this gravelly sand is very retentive of moisture and, on account of the quantity of very fine sand and silt, the capillary power is great. It is this that enables the soil to bring water up from below and to hold water when the soil surface is kept fine and loose by tillage. It is the practice to operate vineyards without irrigation, cultivation every few weeks in spring and summer supplying the requisite moisture.

The Maricopa gravelly sand type of soil covers the greater part of the floor of the San Bernardino Valley, the better portions of it being represented by the soil of the plot. Two of the largest vineyards in the world, that of the Italian Vineyard Company of over 3,000 acres and that of the Riverside Vineyard Company of about 2,500 acres, besides other extensive vineyards, are located in this valley on this type of soil. The conditions in the valley are best suited for the production of grapes for sherry, sweet wine, and brandy purposes. The following areas have been mapped in California: San Bernardino area, 157,000 acres; lower Salinas area, 7,600 acres, and San Gabriel, 30,230 acres.

FIG. 23.— *Vitis longii;* lower side of Solonis Robusta leaf. (Two-thirds natural size.)

In the spring of 1904 plantings consisting of nearly 350 varieties were made in the Cucamonga experiment vineyard. As the phylloxera is not known to exist there, the plantings were principally Viniferas.

Additional plantings were made at Oakville, so that the Oakville plantings consisted of about 10 acres—179 resistant and 57 Vinifera varieties on resistant stocks—and at Fresno, where they consisted of 155 resistant varieties, or about 6 acres.

It is expected that the three vineyards at Oakville, Fresno, and Cucamonga, involving the introduction of viticultural specimens from all parts of the globe, will develop into places for broad viticultural research and experimental work, and will furnish practical object lessons in viticulture and excellent opportunity for correcting the nomenclature of the varieties and for solving many problems of commercial interest.

CHICO VARIETAL VINEYARD.

At the Plant Introduction Garden, 3 miles east of Chico, Cal., 12 acres at the southwest corner have been set aside on which to establish a varietal vineyard. A branch of Butte Creek runs the length of the garden and has deposited the soils as alluvium, formed of material brought down from the mountains and hills on the east. The soil is from 8 to 12 feet deep and underlain by a bed of sandy, water-worn gravel and bowlders, which always carries water. In the winter or spring the water level in the soil may rise to within 6 to 8 feet of the surface. The soil is of light texture, the heaviest being loam. It is well drained and easily cultivated.

FIG. 24.—*Vitis rupestris;* upper side of Rupestris St. George leaf. (Two-ninths natural size.)

In the survey the soil of the vineyard plot has been divided into two classes, light loam and heavy fine sandy loam. The heavy fine sandy loam consists of from 30 to 36 inches of fine sandy loam underlain by very fine sandy loam, usually containing some gravel. The light loam has from 10 to 15 inches of fine sandy loam or sandy loam (usually the latter) underlain by a heavier structure closely approaching loam. The largest area of this soil is found about Chico, including the Chico Rancho. Similar areas occur in portions of the Feather and the Bear river bottoms.

At the Chico vineyard are being assembled and maintained two plants each of grape varieties that prove of special value for specific purposes, including those introduced by the Office of Foreign Seed and Plant Introduction. The collection in this vineyard already

comprises 120 varieties. The mechanical analyses of the soils in the Chico, Cucamonga, Fresno, and Oakville vineyards made by the Bureau of Soils, as well as the temperature and rainfall records in the vineyards, are given in Tables I to VIII, following:

TABLE I.—*Mechanical analyses of samples of soil (fine sandy loam) from the experiment vineyard plot, Chico, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Red gravelly loam, 0 to 12 inches	7.76	1.1	5.6	4.8	20.9	17.5	34.0	16.4
Red gravelly loam, 12 to 24 inches	14.10	1.0	4.8	4.3	19.9	22.4	30.5	16.6
Red gravelly loam, 24 to 36 inches	15.70	1.7	4.7	4.3	21.2	21.9	31.0	15.1
Gravelly loam, 36 to 48 inches	19.10	1.7	6.4	5.6	22.0	20.0	30.8	13.1
Red gravelly loam, 48 to 60 inches	25.00	2.8	9.2	8.1	23.6	18.6	26.3	11.5
Red loam, 60 to 72 inches	3.93	2.5	10.7	9.3	26.1	18.5	22.6	10.9

TABLE II.—*Temperature and rainfall at Chico, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	41.8	44.3	51.0	56.4	68.4	75.0	73.8	75.6	74.8	69.2	54.2	49.5	61.2
1904	45.6	48.8	52.7	58.9	71.8	78.4	80.2	81.0	73.8	60.9	51.7	45.0	62.4
1905	48.8	52.6	55.5	60.9	62.2	72.9	80.1	78.0	70.4	61.4	51.8	43.7	61.5
1906	49.0	54.1	52.8	60.1	64.0	69.7	82.2	78.1	71.2	67.2	51.8	46.2	62.2
1907	43.2	53.2	49.2	60.5	64.1	70.2	78.2	78.4	71.8	67.9	54.0	47.0	61.5
1908	47.1	48.0	53.6	61.2	62.6	71.0	83.8	79.4	72.9	62.4	54.0	43.4	61.6

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	3.90	2.15	6.23	0.40	0.25	T.[a]	0.00	0.00	T.[a]	0.45	7.23	2.15	22.76
1904	0.80	5.64	9.33	2.14	0.00	T.[a]	0.00	0.00	3.38	2.82	2.29	3.99	30.39
1905	7.14	4.85	4.63	1.57	2.04	0.29	0.00	0.04	T.[a]	0.00	1.16	2.39	24.11
1906	6.80	4.57	9.93	1.72	3.09	1.29	0.00	0.02	0.31	T.[a]	0.88	8.66	37.27
1907	6.28	2.09	8.03	1.37	0.13	0.84	0.00	0.00	0.04	0.97	0.14	4.26	24.15
1908	5.34	4.93	0.52	0.41	1.85	0.00	0.00	0.00	0.06	0.26	1.96	2.59	17.92

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	60	71	76	83	101	106	104	106	106	95	81	74	....
1904	66	66	68	94	101	108	106	107	104	87	68	57	....
1905	64	78	81	84	89	95	114	107	95	89	78	69	....
1906	68	76	75	84	89	99	110	104	98	95	82	68	....
1907	65	76	76	84	95	103	106	107	100	96	74	70	....
1908	61	74	82	93	93	104	114	116	104	90	81	66	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	25	20	28	30	40	47	48	50	44	41	31	28	....
1904	27	28	31	33	44	52	53	54	51	38	34	28	....
1905	32	26	33	40	39	51	55	56	41	38	33	25	....
1906	32	37	31	36	36	44	54	51	43	34	21	24	....
1907	24	31	28	40	41	41	52	51	46	49	29	25	....
1908	28	27	25	32	38	43	54	48	45	36	32	22	....

[a] T.=trace.

TABLE III.—*Mechanical analyses of samples of soil (Maricopa medium sand) from the experiment vineyard plot at Cucamonga, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Silty sand, 0 to 12 inches	2.63	3.5	13.3	13.1	45.3	13.6	8.4	2.5
Silty sand, 12 to 24 inches	4.00	3.4	12.3	11.5	43.5	14.7	11.0	2.9
Red silty sand, 24 to 36 inches	2.86	2.8	13.4	11.6	40.4	15.0	12.6	3.3
Red silty sand, 36 to 48 inches	5.10	2.7	15.9	11.5	35.4	13.5	16.2	4.0
Red silty sand, 48 to 60 inches	4.90	5.2	16.9	12.7	35.5	13.6	12.7	3.7
Red silty sand, 60 to 72 inches	4.90	3.1	18.7	12.2	38.4	12.7	10.9	3.3

TABLE IV.—*Temperature and rainfall at Upland, Cal. (nearest point to Cucamonga), 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	52.5	47.8	52.2	55.0	59.4	67.8	71.0	73.2	69.0	66.8	59.5	53.6	60.6
1904	49.8	52.8	53.8	57.6	61.3	68.4	71.2	74.5	70.4	63.1	59.9	52.3	61.3
1905	52.0	52.0	55.0	55.6	57.4	64.1	69.4	72.3	68.4	62.4	52.4	49.3	59.2
1906	47.2	53.5	53.4	56.2	58.8	68.1	76.1	72.4	70.2	67.8	53.8	50.2	60.6
1907	43.8	58.8	53.6	59.4	62.0	67.2	75.2	71.7	69.0	64.4	58.2	53.4	61.4
1908	52.4	50.7	56.4	61.0	60.8	66.7	74.4	71.9	72.0	63.0	56.8	50.8	61.4

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	3.97	2.10	9.45	4.00	0.63	0.00	0.00	0.00	0.42	0.00	0.00	0.00	20.57
1904	0.39	4.26	6.18	1.77	0.30	0.00	T.[a]	0.07	0.00	0.95	0.00	1.09	15.01
1905	4.30	7.92	6.87	0.88	3.54	0.00	0.00	0.00	0.17	0.02	2.96	0.90	27.56
1906	3.88	3.00	14.03	2.42	2.65	0.20	0.11	0.00	T.[a]	0.00	0.75	9.10	36.14
1907	9.71	3.19	7.32	0.53	0.12	0.84	0.00	0.00	0.00	2.14	0.22	1.11	25.18
1908	7.15	4.35	1.40	1.32	0.60	0.00	T.[a]	0.00	1.86	1.03	0.36	1.27	19.34

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	80	78	74	82	90	94	93	100	96	93	82	72	....
1904	76	76	82	90	88	93	93	94	101	86	84	75	....
1905	74	74	78	80	90	88	96	99	94	90	74	69	....
1906	70	72	78	87	78	101	97	100	99	96	87	72	....
1907	66	80	80	86	88	102	108	97	97	89	80	78	....
1908	83	87	88	92	88	99	102	99	105	96	85	78	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	33	26	32	36	39	46	49	42	48	43	38	35	....
1904	28	33	32	34	36	48	50	54	44	39	40	32	....
1905	36	30	36	36	40	42	42	46	44	40	32	28	....
1906	30	31	30	32	42	48	58	50	50	41	30	34	....
1907	28	34	34	45	42	45	50	51	46	46	37	35	....
1908	33	29	31	36	36	39	50	48	44	39	31	27	....

[a] T.=trace.

TABLE V.—*Mechanical analyses of samples of soil (San Joaquin sandy loam, heavy) from the experiment vineyard plot at Fresno, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Brown sandy loam, 0 to 12 inches	0.58	1.2	9.8	6.7	18.4	12.0	33.2	19.7
Brown sandy loam, 12 to 24 inches	0.71	0.9	9.1	6.9	17.8	12.3	32.5	21.4
Sandy loam, 24 to 36 inches	0.51	0.6	8.3	7.8	19.9	12.9	27.1	23.5
Sandy loam, 36 to 48 inches	0.35	0.9	8.8	6.0	13.7	13.1	36.3	21.4
Free sandy loam, 48 to 60 inches	0.11	1.2	14.2	8.6	22.4	15.7	26.5	11.1

TABLE VI.—*Temperature and rainfall at Fresno, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	43.8	45.8	54.9	57.5	67.8	77.2	77.4	80.2	73.6	67.7	55.3	45.6	62.2
1904	44.8	52.4	54.6	60.2	71.4	78.0	79.8	82.8	75.3	63.4	55.6	46.0	63.7
1905	49.2	53.6	58.0	62.4	64.0	74.4	82.4	80.0	73.0	63.6	52.6	43.1	63.0
1906	48.8	55.3	54.2	58.0	63.5	71.6	86.0	82.1	74.0	66.2	51.4	47.4	63.2
1907	46.6	54.0	52.8	62.2	66.0	72.0	79.8	77.9	69.6	64.8	55.4	48.6	62.5
1908	48.0	49.4	56.2	64.1	63.6	72.7	86.5	81.5	74.5	62.2	55.6	41.3	63.0

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	1.86	0.65	2.28	0.50	T.[a]	T.[a]	0.00	0.00	0.00	0.00	0.68	0.22	6.19
1904	0.57	2.49	2.75	1.21	0.12	0.00	0.00	0.00	1.78	3.21	0.08	1.12	13.33
1905	0.93	0.90	2.04	0.45	1.58	0.00	0.00	0.00	T.[a]	0.00	0.96	0.41	7.27
1906	2.05	2.20	4.10	0.92	2.88	T.[a]	T.[a]	0.00	T.[a]	0.00	0.73	3.16	16.04
1907	3.35	0.94	1.74	0.69	T.[a]	0.24	0.00	T.[a]	T.[a]	1.08	0.00	0.97	9.01
1908	1.70	1.75	0.71	0.80	0.63	0.00	0.01	0.00	0.15	0.02	0.66	0.57	7.00

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	66	69	74	85	101	107	103	108	106	95	79	64	....
1904	70	72	75	93	102	105	109	109	108	88	77	68	....
1905	67	77	81	86	96	104	115	107	102	96	77	68	....
1906	69	69	76	93	94	103	111	107	99	94	76	66	....
1907	65	67	77	83	93	101	103	103	98	90	78	74	....
1908	65	75	83	96	94	104	114	113	103	94	84	64	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	26	25	35	35	43	49	52	52	47	46	32	27	....
1904	28	31	35	37	41	54	54	58	52	41	36	29	....
1905	30	29	32	38	43	50	54	56	42	38	32	26	....
1906	28	37	34	34	42	48	59	55	50	36	29	27	....
1907	30	35	30	40	42	42	55	52	49	47	35	32	....
1908	31	32	33	34	40	44	57	52	48	36	31	29	....

[a] T.=trace.

TABLE VII.—*Mechanical analyses of samples of soil (dark-brown heavy gravelly loam) from the experiment vineyard plot at Oakville, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Brown gravelly loam, 0 to 12 inches..	30.00	14.2	14.4	3.5	6.0	4.9	33.8	22.9
Brown gravelly loam, 12 to 24 inches.	20.00	10.6	13.2	3.2	6.2	6.1	35.5	24.5
Brown clayey gravelly loam, 24 to 36 inches..........................	26.25	9.4	13.9	3.6	7.2	7.6	33.4	24.0
Gravelly loam, 36 to 48 inches.........	25.00	5.9	12.9	3.7	7.8	5.8	39.0	24.6
Yellow clayey gravelly loam, 48 to 60 inches..........................	38.20	7.1	13.5	3.7	8.1	7.3	33.7	25.8
Gravelly loam, 60 to 72 inches.........	24.30	6.8	10.0	2.3	5.3	5.2	42.1	27.6

TABLE VIII.—*Temperature and rainfall at Napa (state hospital) (nearest point to Oakville), Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903................	45.0	46.8	51.1	54.6	62.0	66.6	65.8	66.4	66.4	64.6	52.8	48.2	57.5
1904................	45.4	44.9	46.8	54.8	65.8	66.8	65.4	65.6	68.8	62.8	55.2	47.4	57.5
1905................	49.3	51.6	55.5	56.4	57.9	64.4	69.8	69.1	67.5	62.4	52.4	43.0	58.3
1906................	45.9	54.4	51.9	57.4	59.4	64.8	70.9	68.0	68.8	65.6	54.9	49.0	59.2
1907................	45.0	54.2	50.6	58.6	59.6	62.8	66.8	67.5	65.2	63.4	56.0	47.6	58.1
1908................	46.5	47.2	52.0	57.0	59.4	65.3	71.0	67.8	69.4	60.2	52.7	43.2	57.5

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903................	3.22	2.11	4.99	1.13	T.[a]	0.00	0.00	0.00	0.00	0.44	4.25	2.46	18.60
1904................	0.92	8.23	7.93	1.70	0.04	T.[a]	T.[a]	0.08	4.79	2.63	2.01	2.40	30.73
1905................	4.40	2.77	3.44	0.94	2.60	0.00	0.00	0.00	T.[a]	0.00	1.00	1.17	16.32
1906................	6.36	4.28	6.77	0.43	3.23	0.40	0.00	0.00	0.14	0.00	1.74	6.07	29.42
1907................	6.50	4.44	8.37	0.42	0.26	0.85	0.00	0.00	0.01	0.62	0.09	4.37	25.93
1908................	4.15	3.96	0.80	0.14	0.75	0.03	0.00	0.00	0.00	0.37	2.25	2.43	14.88

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903................	62	72	72	79	98	108	104	100	106	97	71	65	....
1904................	66	56	63	88	97	100	93	93	110	92	79	64	....
1905................	65	75	83	77	93	94	110	92	100	94	82	68	....
1906................	74	72	74	85	84	96	103	102	97	95	81	61	....
1907................	63	67	71	86	89	95	90	92	88	99	80	70	....
1908................	59	70	79	87	95	100	102	99	102	88	77	60	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903................	29	26	35	35	38	42	44	45	45	40	33	30	....
1904................	29	31	30	34	42	47	47	47	48	40	38	30	....
1905................	31	29	34	38	41	45	52	50	46	38	30	27	....
1906................	28	36	35	38	40	48	53	51	49	42	31	32	....
1907................	29	37	34	39	43	47	50	54	41	44	34	35	....
1908................	34	33	32	36	39	45	54	50	46	39	34	28	....

[a] T.=trace.

SMALLER VINEYARDS.

In addition to the main vineyards, outlying vineyards of 10 acres each have been established and plantings of resistant and direct producers made and maintained for the purpose of testing varieties

in different altitudes, at varying distances from the ocean, bays, and other bodies of water, under different climatic conditions, and in the leading type of vineyard soils. (See Pl. III.)

FIG. 25.—*Vitis rupestris;* upper side of Rupestris Martin leaf. (Two-thirds natural size.)

COLFAX EXPERIMENT VINEYARD.

The Colfax experiment vineyard is situated on the property of Mr. Louis Cortopassi, on the Sierra Nevada Mountains, 2,422 feet above sea level, $1\frac{1}{2}$ miles southwest of Colfax, Cal. The soil, usually fairly deep and well drained and hilly, originated in the decomposition of the Mariposa formation, consisting of dark shales, or slates, sandstones, or quartzite sandstones, and conglomerates. The large amount of iron present from decomposing volcanic-rock material where exposed to perfect weathering gives the soil a deep-red color. The first few inches are often dark red from the accumulation of organic matter, and the subsoils often yellow from restricted weathering. Rock outcrops of conglomerates, chert, and slates occur on the higher portions.

FIG. 26.—*Vitis vulpina;* upper side of Riparia Gloire de Montpellier leaf. (Two-ninths natural size.)

The native vegetation is manzanita, chaparral, live oak, and yellow pine. The soil was found to conform generally to one distinct type, but on account of slight local differences three varieties were recognized.

In variation No. 1 the brown-red clay is 15 to 18 inches deep and contains enough gravel fragments and organic matter to make it easily tilled. From 18 to about 66 inches of red clay loam or clay occurs; below this to 6 feet or more the clay loam is filled with partially decomposed rock, giving the subsoil a yellow color. This variation occupies the lower portion of the plot.

In variation No. 2 the brownish-red clay loam is 12 inches deep, underlain by red clay to 3 feet; below this the clay becomes yellow and is filled with partially decomposed rock. This variation occupies a more elevated portion of the plot than in type No. 1.

In variation No. 3 dark shaly conglomerate rocks outcrop in spots, and numerous rock fragments occur. The brownish-red clay loam, containing considerable angular gravel, is 8 inches deep, underlain to 3 feet by red clay or clay loam, below which is found yellow clay filled with partially disintegrated and weathered rock fragments. Variation No. 3 occupies the highest portions of the plot.

The extent of this soil type is unknown. The nearest approach to it is the Sierra clay loam mapped in the Sacramento area.

The district in which the Colfax experiment vineyard is located is unique in the diversity of fruit grown and packed by families on sidehill locations.

FIG. 27.—*Vitis vinifera;* upper side of Zinfandel leaf. (Four-ninths natural size.)

GEYSERVILLE EXPERIMENT VINEYARD.

Located on the property of John D. Bosch, the Geyserville experiment vineyard is situated just east of Geyserville, Sonoma County, Cal., against a range of high hills. It is a valley soil laid down by streams. To a depth of 2½ or 3 feet the soil consists of a uniform, dark gravelly loam. Beneath this occurs a subsoil of light-brown or yellowish-brown color, similar in texture to the topsoil. This soil is very mellow and carries considerable humus, which enables it to retain moisture well. Soils of this type produce some of the choicest dry wines (both red and white) of the State. Though not encountered by any of the soil surveys, the type extends over considerable areas along the streams and the floor of the Sonoma Valley, having been washed down from the shale, schist, and conglomerate hills about. The texture of the soil and subsoil through the 6-foot profile is shown in Table X.

LIVERMORE EXPERIMENT VINEYARD.

The Livermore experiment vineyard is situated 3 miles south of Livermore, Alameda County, Cal., on the property of Mr. C. H. Wente. Its position on the valley floor is not far from the low hills. The soil is a very uniform, level, alluvial soil, showing no particular variation over the plot. It is derived from decomposed shales and schists from the surrounding mountains and is full of rounded gravel washed down from the hills. The surface soil is a dark-brown, gravelly loam, which gives way to a gravelly, sandy loam in the second, third, or fourth foot, and this in turn is replaced by gravelly sand in the fifth foot. The humus decreases with the depth, while the gravel increases, varying from 30 to 59 per cent. The proportion of clay is greater than that of silt. This gives the soil a very heavy appearance, the gravel sticking together very tightly when dry or packed. No alkali exists, but ground water is encountered at 5 or 6 feet in places. Soils of this character are known to produce superior white wines of the Sauterne type and are common over the Livermore Valley, but have not been encountered in the surveys made over the State.

FIG. 28.— *Vitis vinifera;* lower side of Zinfandel leaf. (Two-ninths natural size.)

LODI EXPERIMENT VINEYARD.

The Lodi experiment vineyard is about one-fourth of a mile northeast of Lodi, on the property of Mrs. Mary Lawrence. The Bureau of Soils has made no survey of this soil type in California, but a large body is known to exist between Lodi and Acampo. There are two variations on the plot. Phase No. 1 is a brown, free, sandy loam, underlain below 4½ feet by a more adhesive light-brown or yellowish sandy loam. Occasionally iron concretions occur, giving the subsoil a mottled color. The soil has good capillarity, and the water table occurs at between 5 and 6 feet. Phase No. 2, an adhesive sand, was formed by an old stream channel. This is light-brown sand to a depth of 3 feet, the subsoil being waterwashed sand much looser

in texture and lighter in color and dry to a depth of more than 6 feet, the soil texture being too loose to exert much capillary force. The area of this phase is very limited. No hardpan or alkali was found in either phase. These soils are, however, deficient in lime; otherwise they are exceedingly productive, comparatively level, unirrigated, and easily tilled. This locality has a wide reputation for its fine Flame Tokay shipping grapes.

FIG. 29.—*Vitis vinifera;* upper side of Sultanina leaf. (Four-ninths natural size.)

MOUNTAIN VIEW EXPERIMENT VINEYARD.

The Mountain View experiment vineyard is 2 miles west of Mountain View on the west side of the Santa Clara Valley, on the property of Mr. Bernard Distel. The soil in the vineyard is a gravelly phase of Placentia sandy loam, and to 12 inches in depth is quite dark from humus, being a dark red-brown, gravelly, sandy loam. Below this the subsoil becomes redder, sandier, and more gravelly until at 4 feet gravelly sand is encountered. It is well drained, but inclined to become too dry in summer and fall. The surface soil at times becomes quite compact and when plowed breaks up in hard clods. When tilled at the proper time it works into a very mellow condition. These soils originate from washings of granitic sandy shales and schist rocks. The Santa Clara Valley before the destruction of its vineyards by phylloxera and other agencies was at one time the banner dry-wine producing section of the State. The following areas of Placentia sandy loam were surveyed by the Bureau of Soils in California: San Jose, 61,500; lower Salinas, 74,000; Los Angeles,

FIG. 30.—*Vitis vinifera;* lower side of Sultanina leaf. (Four-ninths natural size.)

66,000; San Bernardino, 87,000; San Gabriel, 48,800; and Santa Ana area, 16,800 acres. Soils of the Placentia series occur throughout the coast range of mountains from San Francisco to the Mexican line, occupying undulating portions of valleys close to the hills.

SONOMA EXPERIMENT VINEYARD.

The Sonoma experiment vineyard is about 2 miles south of Sonoma, on low, undulating land lying out of the foothills on the property of the Gundlach-Bundschu Wine Company. The soil is of rather poor quality and to a depth of 8 or 10 inches is a gray loam more easily tilled than its texture indicates. The subsoil to 6 feet or more in depth consists of a clay, changing at 4 feet, with an increase of sand, from light-brown to a yellowish-brown color. The soil is found near where weathered shales from the surrounding hills have been partially broken down and transported into the valleys, where they decompose in soil. This soil usually occupies small, undulating ridges, or elevations, and is surrounded by the dark-brown, alluvial clay loam of the valley floor. Surface drainage is good, and no injurious quantity of alkali exists. This soil produces superior white wines of the Riesling, Chasselas, and Traminer types. The Bureau of Soils has made no survey of this type of soil in California, but it is known to exist over extensive areas in the Sonoma Valley and in the adjacent bay region.

STOCKTON EXPERIMENT VINEYARD.

The Stockton experiment vineyard is on the property of the San Joaquin Valley Realty Company, a little over a mile southeast of Stockton, on the largest body of Stockton clay loam adobe found in the soil survey of the area. This soil type, locally known as black adobe, was laid down in a swamp or tidal marsh in quiet water, the decomposing vegetation giving it the black color. It is a clay loam in texture, adhesive and sticky when wet and when dry very hard, cracking into large, cubical blocks full of small, cubical fractures. Sufficient rain slacks the clods readily. Cultivated when in the right condition, the soil is friable and pulverizes well, but when either too wet or too dry great difficulty is experienced in tilling it.

The subsoil is a light-yellow, silt loam, much lighter than the surface soil, from which it is usually separated at a depth of 2½ feet by a thin stratum, about one-half inch thick, of rather soft marly or calcareous hardpan, which is not always continuous and is often broken or disintegrated. Roots and water readily penetrate the subsoil, often passing through the hardpan. The water table varies with the seasons, averaging from 3½ to 6 feet for the wet seasons and from 6 to 10 feet for the dry ones. This variation is influenced by a thin, marly

hardpan, which appears to hold the water down under pressure. The heavy texture of this soil prevents the alkali from concentrating on the surface from rapid passage of water upward through capillary attraction. This and occasional floods, from which vineyards seem not to suffer, keep the alkali evenly distributed throughout the 6 feet of soil. It is somewhat difficult to establish vineyards on these soils, but they are very productive and lasting. Grapes for diverse purposes are grown on them. One of the largest sweet-wine establishments of the State is located near Stockton, and heavy shipments of table grapes grown on these soils are made.

Soils of this type have been mapped in California as follows: Stockton, 53,312; Hanford, 5,470; and Fresno area, 5,664 acres. This soil has also been identified but not surveyed between the Marysville buttes and about North Durham, in the Sacramento Valley, where it covers many thousand acres.

Mechanical analyses of the soils in the Colfax, Geyserville, Livermore, Lodi, Mountain View, Sonoma, and Stockton experiment vineyards, made by the Bureau of Soils, and temperature and rainfall records in them or at localities very near them are given in Tables IX to XXII, following:

TABLE IX.—*Mechanical analyses of samples of soil (red clay loam) from the experiment vineyard plot at Colfax, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Red clay loam, 0 to 12 inches	24.20	3.9	7.9	3.2	7.2	7.3	37.8	32.1
Red clay, 12 to 24 inches	19.20	3.4	6.3	2.7	5.6	5.1	30.4	45.5
Red volcanic clay, 24 to 36 inches	16.25	2.1	5.2	2.3	6.2	5.8	33.1	44.5
Red volcanic clay, 36 to 48 inches	11.00	2.6	6.5	2.5	6.5	7.0	35.0	38.9
Red volcanic clay, 48 to 60 inches	21.60	3.3	8.3	3.6	9.0	5.1	33.7	36.1
Red volcanic clay, 60 to 72 inches	32.00	4.1	8.6	3.2	7.5	5.4	33.5	36.8

TABLE X.—*Mechanical analyses of samples of soil (dark-brown gravelly loam) from the experiment vineyard plot at Geyserville, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Red gravelly loam, 0 to 12 inches	29.10	7.3	15.9	4.7	10.3	10.4	32.1	18.6
Brown gravelly loam, 12 to 24 inches	36.60	9.0	13.1	4.7	9.6	8.1	35.8	19.9
Brown gravelly loam, 24 to 36 inches	33.80	9.0	13.7	4.1	10.0	8.8	34.6	19.2
Red gravelly loam, 36 to 48 inches	37.50	7.6	12.2	4.8	11.1	9.2	35.8	19.1
Brown gravelly loam, 48 to 60 inches	37.20	6.6	12.2	4.6	11.5	11.8	33.8	19.2
Brown gravelly loam, 60 to 72 inches	37.00	8.6	12.5	5.1	12.0	10.5	33.0	18.9

TABLE XI.—*Mechanical analyses of samples of soil (gravelly sandy loam or loam) from the experiment vineyard plot at Livermore, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Gravelly loam, 0 to 12 inches	33.33	5.1	11.4	5.6	13.2	12.6	30.5	22.0
Gravelly sandy loam, 12 to 24 inches	36.66	7.2	12.9	5.9	13.6	12.2	26.2	22.1
Gravelly coarse sandy loam, 24 to 36 inches	59.80	14.3	21.2	8.0	14.1	8.2	14.9	18.9
Gravelly coarse sandy loam, 36 to 48 inches	56.32	14.0	22.6	9.1	16.6	7.4	12.5	18.0
Gravelly sand, 48 to 60 inches	52.74	17.6	33.0	10.0	12.4	4.6	8.2	14.3

TABLE XII.—*Mechanical analyses of samples of soil (loose sandy loam) from the experiment vineyard plot at Lodi, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Sandy loam, 0 to 12 inches	0.33	1.6	19.8	13.5	25.9	15.2	16.4	7.7
Sandy loam, 12 to 24 inches	0.17	1.8	19.9	14.4	26.6	13.2	15.9	8.2
Sandy loam, 24 to 36 inches	0.19	2.2	22.1	14.5	25.7	13.3	14.5	8.0
Sandy loam, 36 to 48 inches	0.26	1.4	15.1	12.5	25.8	15.6	19.1	10.5
Sandy loam, 48 to 60 inches	0.16	1.0	17.2	14.3	25.7	15.2	17.9	8.6
Sandy loam, 60 to 72 inches	0.30	1.1	19.4	13.7	24.8	15.5	18.6	7.0

TABLE XIII.—*Mechanical analyses of samples of soil (gravelly sandy loam) from the experiment vineyard plot at Mountain View, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Brown gravelly loam, 0 to 12 inches	30.79	11.6	18.8	6.8	13.4	8.7	24.5	16.5
Brown gravelly loam, 12 to 24 inches	32.74	8.5	17.2	8.1	16.2	8.5	23.3	19.0
Brown gravelly loam, 24 to 36 inches	39.21	12.0	19.9	8.8	16.5	8.4	19.6	14.9
Brown gravelly sandy loam, 36 to 48 inches	38.80	19.6	36.1	11.7	12.0	3.0	8.7	9.3
Gravelly loam, 48 to 60 inches	40.90	18.2	31.6	12.0	15.8	3.9	9.1	8.8

TABLE XIV.—*Mechanical analyses of samples of soil (gray-brown clay) from the experiment vineyard plot at Sonoma, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Gray loose soil, 0 to 12 inches	2.00	0.6	1.7	1.3	11.0	13.6	52.2	19.1
Light-brown clay, 12 to 24 inches	1.85	0.4	1.2	0.8	7.0	10.2	43.2	37.4
Brown sticky clay, 24 to 36 inches	1.35	0.7	1.7	1.1	6.2	10.5	40.5	39.1
Light-brown sand, 36 to 48 inches	2.80	0.1	0.4	0.4	2.8	9.3	45.2	41.3
Sand and clay, 48 to 60 inches	0.00	0.1	0.3	0.3	4.5	8.7	49.0	37.2
Yellow sand and clay, 60 to 72 inches	0.00	0.3	0.5	0.3	4.9	11.2	45.6	36.3

TABLE XV.—*Mechanical analyses of samples of soil (Stockton clay loam adobe) from the experiment vineyard plot at Stockton, Cal.*

Description.	Coarse gravel.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Black adobe, 0 to 12 inches	1.19	0.5	4.6	4.4	12.5	14.9	35.0	27.7
Black adobe, 12 to 24 inches	1.45	1.4	4.3	3.8	13.2	13.1	34.4	30.6
Brown clay, 24 to 36 inches	2.04	1.3	5.5	4.5	17.6	15.6	31.9	24.1
Brown sand, 36 to 48 inches	1.40	0.7	6.9	5.2	17.1	16.0	34.8	19.5
Brown sand, 48 to 60 inches	3.03	2.9	19.2	9.3	11.4	8.8	29.4	19.3
Yellow sand, 60 to 72 inches	4.55	1.9	8.0	6.5	11.1	11.1	39.2	22.4

TABLE XVI.—*Temperature and rainfall at Colfax, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	41.5	37.4	41.4	52.0	66.3	75.8	67.6	72.8	67.2	62.6	51.6	46.9	56.9
1904	45.4	43.3	45.9	51.5	67.0	75.8	76.8	78.7	70.0	64.9	57.5	46.0	60.2
1905	48.4	49.0	50.9	55.2	57.3	69.2	77.6	75.7	69.5	58.0	48.6	42.0	58.4
1906	51.4	51.4	46.5	53.2	55.6	61.6	76.8	74.0	65.8	60.4	47.1	45.4	57.4
1907	37.3	49.9	48.2	53.8	64.5	63.0	75.1	76.5	63.7	61.3	60.4	51.0	58.7
1908	44.0	44.5	44.3	54.3	54.2	75.2	80.4	76.2	67.8	58.3	52.5	39.6	57.6

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	10.80	4.00	12.95	3.50	0.10	T.[a]	0.00	0.00	0.00	1.44	18.38	2.25	53.42
1904	3.50	20.10	20.46	4.85	0.58	T.[a]	T.[a]	0.00	5.50	7.17	2.53	5.90	70.59
1905	5.36	6.11	6.11	3.01	3.21	0.20	0.00	0.00	0.53	T.[a]	2.36	2.78	29.67
1906	21.62	8.98	19.28	2.72	7.54	3.48	0.00	0.00	0.20	T.[a]	3.88	17.51	85.21
1907	9.45	9.75	19.46	2.43	0.52	2.90	0.00	0.02	0.00	0.58	0.13	10.04	55.28
1908	5.00	4.56	3.68	1.86	5.19	1.25	0.00	0.00	0.35	3.20	2.74	4.09	31.92

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	58	62	62	75	95	98	95	98	93	86	74	68	....
1904	68	68	59	78	93	100	98	99	99	87	73	68	....
1905	72	73	89	78	86	92	107	103	......	86	76	69	....
1906	70	88	74	85	84	97	102	102	94	91	82	74	....
1907	67	78	70	82	92	90	98	......	94	78	80	78	....
1908	56	61	75	......	94	110	103	108	96	90	78	50	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	32	22	27	30	35	45	48	60	51	45	32	36	....
1904	23	30	30	31	32	55	52	61	47	44	39	29	....
1905	30	29	29	35	32	40	52	49	......	36	31	22	....
1906	26	30	24	27	30	38	52	38	34	24	18	19	....
1907	14	22	25	25	38	34	48	......	38	42	38	30	....
1908	30	29	25	......	32	38	55	50	40	30	34	20	....

[a] T.= trace.

Table XVII.—*Temperature and rainfall at Cloverdale (nearest point to Geyserville), Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	47.2	46.8	50.0	55.8	63.8	73.0	70.0	72.6	68.6	66.4	54.6	49.6	59.9
1904	48.6	48.2	49.6	56.9	67.4	71.6	70.6	70.2	69.8	62.6	55.8	48.4	60.0
1905	49.0	52.7	56.2	58.2	59.9	66.8	73.2	71.0	68.8	63.3	54.6	47.0	60.1
1906	49.2	53.5	51.8	58.2	59.8	65.8	75.0	70.2	68.9	65.6	54.4	48.9	60.2
1907	44.5	55.4	49.6	59.7	62.3	66.2	70.4	69.4	64.9	62.0	55.4	48.8	59.0
1908	47.9	49.3	55.0	60.2	58.8	65.8	73.0	68.6	69.2	59.4	54.1	45.0	58.9

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	6.49	2.89	7.05	0.34	0.00	0.22	0.00	0.00	0.00	1.22	10.11	3.86	32.18
1904	2.13	16.34	16.57	3.22	0.33	T.[a]	0.04	0.04	4.21	4.79	3.48	7.88	59.03
1905	10.29	6.02	8.71	1.63	3.51	0.00	0.00	0.00	0.07	T.[a]	2.32	2.89	35.44
1906	15.86	7.21	10.78	1.55	4.12	1.48	0.00	0.00	0.06	0.00	2.10	11.45	54.61
1907	10.69	5.33	19.08	0.90	0.33	0.62	T.[a]	T.[a]	0.15	1.02	0.34	9.50	47.96
1908	6.71	7.87	1.27	0.59	1.51	0.08	T.[a]	0.00	0.04	1.75	3.31	3.81	26.94

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	64	71	72	84	101	110	104	105	104	95	76	71	....
1904	71	65	73	92	103	104	106	102	110	92	82	68	....
1905	68	80	87	85	94	96	115	105	102	94	83	75	....
1906	74	75	82	87	86	97	107	106	99	94	80	65	....
1907	65	73	76	99	95	100	97	100	90	98	83	73	....
1908	69	75	87	95	93	101	103	105	99	94	86	62	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	27	25	30	33	34	44	42	44	42	39	33	30	....
1904	29	31	30	33	38	45	43	44	45	40	39	31	....
1905	29	24	33	36	41	43	45	45	40	37	27	28	....
1906	30	36	32	36	38	44	49	40	40	33	27	27	....
1907	28	34	31	37	40	43	50	45	41	41	34	31	....
1908	31	30	33	34	36	42	47	40	41	34	30	24	....

[a] T.=trace.

Table XVIII.—*Temperature and rainfall at Livermore, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	47.4	46.6	52.9	55.4	62.8	68.2	68.0	69.2	68.9	65.8	55.6	48.6	59.1
1904	47.2	50.1	53.0	56.4	64.0	69.0	69.4	69.0	71.4	62.8	54.5	47.1	59.5
1905	49.0	51.6	56.3	57.2	57.9	65.1	70.6	69.4	68.8	62.4	54.6	46.8	59.1
1906	49.6	54.4	53.2	56.8	59.8	65.8	75.2	71.8	68.4	64.7	53.5	48.1	60.1
1907	46.6	55.0	50.6	59.6	60.4	64.8	68.8	69.6	66.2	63.3	56.1	49.6	59.2
1908	50.2	50.4	55.0	58.9	58.6	64.5	74.2	71.2	69.2	59.9	54.4	44.4	59.2

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	3.19	0.94	5.65	0.81	0.12	0.00	0.00	0.00	0.00	T.[a]	2.16	0.59	13.46
1904	0.89	4.18	3.71	1.56	0.24	T.[a]	T.[a]	0.32	1.62	1.00	0.78	1.42	15.72
1905	2.43	2.30	3.12	0.93	1.89	0.00	0.00	0.00	T.[a]	0.00	1.61	1.18	13.46
1906	5.56	2.67	5.18	0.95	1.61	0.56	T.[a]	0.00	0.20	0.03	1.34	6.45	24.55
1907	3.22	1.86	8.85	0.47	0.16	0.56	0.00	0.00	T.[a]	0.81	0.04	3.90	19.87
1908	2.27	1.35	0.75	0.28	0.53	T.[a]	T.[a]	0.00	0.03	0.27	0.60	1.55	7.63

[a] T.=trace.

TABLE XVIII.—*Temperature and rainfall at Livermore, Cal., 1903–1908*—Continued.

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	67	73	75	83	102	108	100	103	106	95	81	69	....
1904	70	65	73	92	98	103	103	98	108	94	83	67	....
1905	69	79	83	84	95	96	113	106	105	95	82	71	....
1906	71	74	78	90	84	102	109	106	101	96	85	73	....
1907	66	75	71	84	92	99	96	101	90	93	82	73	....
1908	64	75	83	93	92	103	106	107	102	90	87	66	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	23	26	31	30	38	43	45	46	42	41	31	27	....
1904	27	29	31	34	37	45	44	46	48	36	31	26	....
1905	29	24	32	36	36	43	45	44	44	34	32	26	....
1906	28	35	32	36	37	43	49	49	41	35	25	26	....
1907	27	32	30	39	39	42	45	48	42	39	33	27	....
1908	30	36	31	35	34	39	50	46	43	34	29	25	....

TABLE XIX.—*Temperature and rainfall at Lodi, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	44.6	43.0	52.4	54.6	64.5	71.4	69.4	70.1	68.2	62.5	54.2	45.1	58.3
1904	42.9	49.4	53.6	56.8	66.0	71.0	71.2	71.1	70.4	60.2	52.2	45.8	59.2
1905	48.2	50.6	55.4	59.0	60.8	67.6	72.4	70.8	67.0	58.8	51.0	42.4	58.7
1906	46.8	53.7	52.8	57.4	60.3	67.0	76.8	72.6	66.6	61.8	51.2	47.2	59.5
1907	45.7	54.6	50.7	59.2	63.0	66.8	70.9	69.4	63.8	61.8	52.3	47.8	58.8
1908	48.0	48.0	52.4	59.4	60.9	67.6	76.3	71.0	68.6	57.8	51.2	43.5	58.8

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	3.21	1.79	10.31	0.23	0.00	0.00	0.00	0.00	0.00	0.03	3.58	1.01	20.16
1904	0.72	5.77	4.85	1.44	0.29	0.00	0.00	0.03	2.29	2.11	1.50	1.66	20.66
1905	3.49	2.86	4.06	0.80	2.39	0.00	0.00	0.00	0.03	0.00	0.61	0.70	14.94
1906	5.96	3.30	8.70	1.95	2.71	0.46	0.00	T.[a]	0.14	T.[a]	1.09	9.47	33.78
1907	3.94	2.82	6.76	0.15	0.00	1.61	T.[a]	0.00	0.00	0.40	0.09	3.96	19.73
1908	5.07	1.51	0.83	0.14	0.81	0.00	0.00	0.00	0.16	0.41	1.33	1.21	11.47

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	65	65	72	81	102	104	100	100	100	88	74	58	....
1904	60	64	76	84	98	99	100	96	105	84	67	60	....
1905	66	72	75	82	94	96	110	101	98	88	78	61	....
1906	64	70	76	87	86	96	104	101	92	86	76	58	....
1907	64	69	69	79	92	95	96	96	88	86	73	63	....
1908	63	66	80	87	93	103	105	104	97	84	73	60	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	27	24	32	33	41	46	45	45	41	38	31	29	....
1904	27	28	32	34	44	46	47	49	47	36	34	27	....
1905	29	29	33	38	40	43	46	46	43	31	30	23	....
1906	28	36	31	36	40	46	50	49	45	31	25	23	....
1907	28	33	31	40	42	43	51	50	44	40	30	28	....
1908	31	31	30	34	38	43	52	46	43	34	28	30	....

[a] T.=trace.

TABLE XX.—*Temperature and rainfall at Santa Clara (nearest point to Mountain View), Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	47.8	46.2	52.7	53.6	59.5	63.8	64.0	64.8	64.7	63.2	55.6	49.6	57.1
1904	47.1	50.8	53.4	56.6	61.5	65.7	65.0	64.9	67.6	61.4	55.2	47.7	58.1
1905	50.2	54.0	56.6	56.8	56.9	61.8	67.8	65.5	64.4	59.6	53.5	46.8	57.8
1906	50.4	55.6	54.2	56.6	59.0	63.3	69.0	67.4	65.1	61.0	53.0	48.6	58.6
1907	47.5	55.3	50.7	58.0	59.4	62.8	66.1	66.0	61.8	60.8	54.6	50.8	57.8
1908	49.8	49.4	53.0	57.0	56.6	60.8	68.4	65.7	65.0	58.0	53.8	45.1	56.9

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	3.09	1.50	5.74	0.82	0.00	0.00	0.00	0.00	0.00	0.12	1.85	0.39	13.51
1904	1.03	3.47	3.92	1.75	0.36	0.00	0.00	0.42	3.01	1.41	1.04	2.50	18.91
1905	2.42	3.16	3.06	1.10	2.01	0.00	0.00	0.00	T.[a]	0.00	2.02	1.44	15.21
1906	3.90	2.71	6.17	0.93	1.02	0.52	0.00	0.00	0.38	T.[a]	1.02	6.50	23.15
1907	5.01	2.02	9.22	0.44	0.13	0.47	0.00	0.00	0.12	1.16	0.13	3.60	22.30
1908	2.82	2.74	1.35	0.24	0.61	0.00	0.00	0.00	0.13	0.16	1.02	1.68	10.76

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	69	71	74	79	92	106	99	93	99	92	71	71	....
1904	69	69	75	91	92	101	94	90	109	89	84	64	....
1905	68	76	82	80	94	87	111	92	98	91	80	71	....
1906	74	75	78	94	82	99	99	99	95	93	81	65	....
1907	65	71	74	82	88	95	90	89	86	92	77	75	....
1908	67	71	80	89	89	98	96	95	95	93	80	67	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	26	23	32	30	36	37	40	42	38	37	31	27	....
1904	26	30	32	34	37	42	42	43	45	36	34	27	....
1905	29	26	33	36	37	41	40	40	37	33	32	25	....
1906	29	34	30	36	36	40	43	45	40	30	27	25	....
1907	28	32	31	38	37	41	42	45	38	38	30	31	....
1908	30	29	29	29	36	36	45	39	38	31	28	24	....

[a] T.=trace.

TABLE XXI.—*Temperature and rainfall at Sonoma, Cal., 1903–1907.*

MEAN TEMPERATURE (°F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	46.6	50.6	51.8	57.2	63.4	67.2	65.8	66.0	65.3	63.6	55.6	48.9	58.5
1904	47.5	49.6	52.0	57.6	65.0	68.0	66.0	64.0	68.0	61.2	55.3	48.0	58.5
1905	49.4	52.4	57.0	......	63.6	63.2	66.0	65.0	64.6	59.8	......	46.4	....
1906	47.8	54.4	52.8	55.9	58.3	65.1	67.8	65.6	65.2	63.0	55.6	48.0	58.3
1907	45.8	55.3	50.9	58.6	57.3	61.7	61.6	......	......	......	......	......	....

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	5.46	2.01	5.49	0.50	0.00	T.[a]	0.00	0.00	0.00	0.34	6.38	2.97	23.15
1904	1.88	9.08	10.50	1.62	0.00	0.00	0.05	T.[a]	4.10	4.05	1.91	3.57	36.76
1905	5.21	3.45	5.91	1.06	3.27	0.00	0.00	0.00	T.[a]	T.[a]	1.74	1.80	22.44
1906	8.18	5.10	7.46	0.63	2.78	0.51	0.00	0.00	0.16	0.00	1.50	8.44	34.76
1907	6.91	7.21	11.46	0.35	0.14	0.81	0.00	......	......	......	......	......	....

[a] T.=trace.

TABLE XXI.—*Temperature and rainfall at Sonoma, Cal., 1903–1907*—Continued.

MAXIMUM TEMPERATURE (°F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	63	74	72	80	92	103	98	93	97	91	73	72	....
1904	68	62	71	88	88	94	91	89	105	83	78	66	....
1905	69	76	82	85	90	86	106	91	97	90	......	72	....
1906	70	72	75	83	80	95	96	98	92	90	82	67	....
1907	63	71	79	87	82	92	90	......	......	......	......	......	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	29	27	35	31	43	45	48	46	44	40	34	29	....
1904	30	31	32	34	46	52	47	47	47	41	36	30	....
1905	32	32	36	......	45	43	45	44	40	32	......	23	....
1906	30	35	31	37	40	46	45	48	42	35	26	27	....
1907	28	37	30	36	37	40	36	......	......	......	......	......	....

TABLE XXII.—*Temperature and rainfall at Stockton, Cal., 1903–1908.*

MEAN TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	42.8	43.5	51.4	54.8	64.3	70.7	69.6	70.8	68.4	63.6	52.7	44.4	58.08
1904	42.8	48.6	51.6	55.6	66.1	71.3	71.3	71.3	70.9	60.4	50.8	44.8	61.29
1905	46.8	48.0	54.2	55.8	57.5	66.8	73.6	71.6	68.4	60.8	49.7	42.5	61.30
1906	46.2	51.1	50.6	54.1	58.6	67.2	77.9	73.6	68.4	63.0	51.6	46.0	59.02
1907	45.0	53.8	51.2	60.3	63.2	66.6	71.8	70.8	65.0	62.4	53.7	47.3	59.26
1908	46.7	48.2	53.2	60.4	60.3	67.0	76.0	70.8	68.8	58.8	52.3	41.0	58.58

PRECIPITATION (INCHES).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	2.50	1.12	7.29	0.33	0.08	0.00	0.00	0.00	0.00	0.05	3.06	0.73	15.16
1904	0.54	4.09	3.67	1.81	0.28	0.00	0.00	0.12	2.32	1.51	1.28	1.23	16.85
1905	3.11	2.38	3.13	0.72	2.38	0.00	0.00	0.00	0.04	0.00	0.86	0.51	13.13
1906	4.69	2.85	5.88	1.74	1.70	0.41	0.00	T.[a]	0.10	T.[a]	1.01	8.05	26.43
1907	3.94	2.52	6.03	0.10	T.[a]	0.74	T.[a]	0.00	T.[a]	0.54	T.[a]	3.79	17.66
1908	4.00	1.36	0.50	0.12	0.78	0.00	0.00	0.00	0.19	0.39	1.20	1.30	9.84

MAXIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	63	65	67	78	95	103	96	98	97	87	70	59	....
1904	59	60	66	84	93	100	98	94	104	85	68	60	....
1905	61	60	76	80	90	93	110	100	96	86	76	58	....
1906	60	62	68	87	84	96	104	101	91	86	77	63	....
1907	64	67	70	78	88	94	93	94	84	84	71	66	....
1908	60	70	76	87	89	100	101	103	95	85	77	61	....

MINIMUM TEMPERATURE (° F.).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1903	25	24	33	39	43	43	50	52	48	42	33	29	....
1904	27	30	34	36	43	51	51	52	52	41	35	29	....
1905	29	24	36	41	43	48	50	50	48	40	34	25	....
1906	28	36	35	40	42	48	53	48	49	36	25	26	....
1907	31	38	35	45	45	44	54	53	49	43	31	30	....
1908	33	33	32	39	40	45	54	42	46	37	29	26	....

[a] T.=trace.

GENERAL PLAN OF PLANTINGS IN THE EXPERIMENT VINEYARDS.

In the plotting of all of the experiment vineyards, the general plan of providing space for ten vines between the cross avenues or roadways has been adopted (see Pl. VII, figs. 2 and 3), the distance apart varying with the soil. Not only are all of the plantings of resistants for comparative test and study made in regular checks of ten vines of each variety, but all of the larger plantings of resistant varieties for grafting purposes are also in ten-vine blocks between the avenues. Regular checks of ten vines of each stock have been grafted with the prominent Vinifera varieties whose congeniality is being tested on various stocks, and where only preliminary readings of Vinifera varieties are desired, the grafts put in have been a divisor of ten in a check of ten vines.

MANNER OF KEEPING RECORDS.

Accurate records are kept of all varieties from the time they are planted or grafted; their behavior and growth are closely watched, and as soon as they have progressed sufficiently, detailed descriptions are made of the vines and fruit and their apparent value for specific uses, and their adaptability to different conditions is recorded. Each vine receives its block, row, and vine number, and a complete history of each individual vine or graft is kept, giving its source and behavior and all that has been done with it from the time it came into the possession of until it was dispensed with by the Department. Through this system any vine or graft not true to name is kept track of and no wood or fruit of it used with that of others.

The Department's experiment vineyards are easy of access to the majority of grape growers in California (see Frontispiece), and it is believed that a study of the varieties and observation of the experimental work in progress would yield them much valuable information (see fig. 1). Grape growers in the State are invited to avail themselves of the opportunity from time to time and visit one or more of these vineyards.

The writer has been assisted in the viticultural investigations by Mr. G. H. Hecke from October, 1904, to March 15, 1906; by Mr. Andrew Rasmussen from June 1, 1906, to January 31, 1907; by Mr. Alfred Tournier from March, 1907, to February 20, 1909; and by Mr. Fred L. Husmann from August 1, 1907, to date.

GROWTH RATINGS OF RESISTANT VINES AND DIRECT PRODUCERS.

In the following table the upper numbers after each name in the columns headed "Experiment vineyard" show the years when the

vines were planted; the lower numbers show the growth ratings, which in each case were made in the autumn of 1908.

The growth of each variety at each vineyard where it is under test is expressed in the form of a percentage rating on a scale in which the growth of the variety under conditions for which it is well adapted is taken as the standard of excellence, 100 per cent. These ratings therefore represent the behavior of each variety under the conditions existing at the several vineyards, expressed in terms that permit comparison with its behavior elsewhere, and are not based on comparison with other varieties in the same vineyard. Each variety is therefore rated on a scale based on its own standard of excellence rather than on any arbitrary scale formulated for application to all varieties.

It is believed that this method renders possible a truer expression of the reaction of each variety to different soil and climatic conditions than any arbitrary scale or measurement of growth would do.

To illustrate, the Rupestris St. George planted at Colfax in 1906 was rated 100, whereas planted at Chico the same year it was rated 95, and planted at Mountain View in 1904 it was rated only 65. This shows that at Colfax the growth and behavior were entirely satisfactory, and therefore rated at 100; at Chico very good, but not quite as good as at Colfax, and therefore rated at 95; and at Mountain View it had made a much poorer growth, which, as compared with the growth made at Colfax, was as 65 to 100, or 65 per cent.

Table XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, showing the year of planting in each vineyard and the relative growth rating.*

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Adobe Giant	1903 75	1903 90	....	....	....	1907	1904 89	....	1906 95	1906 90	1907 70
(Aestivalis × Monticola) × (Riparia × Rupestris. No. 554–5)	1904 85	1904 95	....	....	1904 85	1904 90	1904 94	1904 80	1906 85	1906 85	1908 ......
(Aestivalis × Rupestris) × Riparia, No. 227	1905 90	....	....	....	1905 90	1905 90	....	....	....	1906 60	....
Agawam	1905 90	1905 95	....	....	....	....	....	....	....	1906 75	....
Albania	1903 95	1904 30	....	....	....	....	....	....	....	....	....
Alicante Bouschet × Cordifolia, No. 142 B	1905 90	1906 85	....	....	....	1907	....	....	1906 95	1906 92	1907 80
Alicante Bouschet × Riparia, No. 141 A	1904 85	1904 99	....	1907	1907	1907	....	1907 98	....	....	1908 ......
Alicante Ganzin	1907	....	....	....	....	....	....	....	....	1907 90	....

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Alicante × Rupestris Terrace, No. 20	1903		1905						1906		1907
	95		95						100		87
Amerbonte	1903	1904			1907					1907	
	95	50								89	
America	1903	1903		1904	1904	1904	1904	1904		1907	
	90	65		70	90	90	80	60		80	
Aminia			1905								
			50								
Aramon × Riparia, No. 143 A	1904	1904									1907
	75	90									
Aramon × Rupestris Ganzin, No. 1	1904			1904	1904	1904	1904	1904	1906	1907	1908
	85			98	90	70	93	98	95	98	
Aramon × Rupestris Ganzin, No. 2	1904	1904	1907	1904	1904	1904	1904	1904	1906	1907	1908
	85	95		75	90	80	92	65	100	90	
Aramon × Rupestris Ganzin, No. 9	1904	1904		1904	1904	1904	1904	1905		1906	1907
	75	80		75	70	85	60	96		90	90
Atoka	1903	1905			1907						
	95	70									
Australis	1903	1903		1904	1907	1904	1904	1904	1906	1906	1907
	90	99		85		95	88	90	80	85	
Barnes	1903	1903	1907	1907	1907				1906	1906	1907
	95	90							85	85	87
Barry	1905	1905		1905	1905	1905	1905	1905		1906	
	85	80		60	75	90	78	80		70	
Berckmans	1904	1904			1904	1904	1904	1904			
	80	75			80	70	70	75			
Berlandieri, No. 1	1904	1904		1904	1904	1904	1904	1904	1906	1906	
	85	80		70	75	85	90	85	85	75	
Berlandieri, No. 2	1904	1906					1906		1906	1906	
	50	80					80		85	78	
Berlandieri Lafont, No. 9	1904	1904		1905	1904	1905	1904	1905		1906	
	80	80		70	70	85	92	65		65	
Berlandieri × Riparia, No. 33 E. M.	1904	1904			1904			1904	1906	1907	1907
	90	70			75			65	85	80	80
Berlandieri × Riparia, No. 34 E. M.	1904	1904		1907	1904	1907	1904		1906	1906	1907
	95	80			70		85		90	85	85
Berlandieri × Riparia, No. 157-11	1904	1904			1904		1904	1904	1906	1907	1907
	90	70			85		95		90	88	80
Berlandieri × Riparia, No. 420 A	1904	1903			1904	1905	1904	1904	1907	1907	
	92	94			94	95	70	94	80	80	
Berlandieri × Riparia, No. 420 B	1904	1904		1907	1904			1904	1907		
	90	85			70			75	80		
Big Extra	1903	1905		1904	1904	1904	1904	1904	1907		1907
	95	95		60	99	75	93	98	90		65
Blondin	1903	1904									
	95	40									
Bourisquou × Rupestris, No. 601	1903	1903	1905	1907	1906	1907			1906	1906	
	95	90	85		60				85	95	
(Bourisquou × Rupestris, No. 601) × Calcicola, No. 13205	1905	1905		1905	1907		1907			1906	
	85	85		90			90			95	
Bourisquou × Rupestris, No. 603	1904	1904		1905	1905	1905		1905	1906		
	75	80		90	65	70		90	95		
Bourisquou × Rupestris, No. 109-4	1904	1904	1907	1904	1904	1905	1904	1905	1907	1906	1907
	95	95		98	99	85	87	95	80	95	96
Bourisquou × Rupestris, No. 3907	1904	1904	1907	1904	1904	1904	1904	1904	1906	1906	
	95	90			95	80	87	95	90	85	
Bourisquou × Rupestris, No. 4306	1904	1904	1907	1907	1904	1907	1907		1907	1906	1908
	95	95			60		85		95	97	
Bourisquou × Rupestris, No. 4308	1904	1904	1907		1904				1906	1907	1908
	90	99			85				95	93	
Brighton	1905		1905						1906	1906	
	85		60						80	85	
Brilliant	1904	1904	1905	1905	1904		1904				
	75	95	55	60	85		85				
Cabernet × Berlandieri, No. 333	1903	1903		1904	1904		1904				1907
	90	84		70	92		92				70
Cabernet × Rupestris Ganzin, No. 33 A	1904	1904	1907	1904	1904	1905	1904	1905			
	90	98		85	90	70	85	75			

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Canada	1903 90	1903 75	......	......	......	1906 75	......	1906 90	......	1906 90	1907 80
Captain	1903 90	1904 95	......	......	1906 40	......	......	......	1907 90	1906 80	1907 80
Carignane × Rupestris, No. 404	1904 90	1904 99	......	1905 80	1904 80	1907	1904 85	......	......	1906 87	1907 95
Carignane × Rupestris, No. 501	1904 85	......	......	......	1904 90	1907	......	1904 92	......	1907 92	1908 ......
Carman	1903 85	1904 80	......	......	......	......	......	......	......	......	......
Castel, No. 1028	1907	......	......	......	......	......	......	......	......	1907 80	......
Catawba	1905 90	1905 85	......	1905 60	1905 70	1905 95	1905 94	1905 95	1906 75	1906 85	......
Centennial	1905 90	1905 90	1905 85	......	......	......	......	......	1907 85	......	......
Champenel	1903 95	......	......	......	......	......	......	......	......	1906 85	1907 97
Chasselas × Berlandieri, No. 41 B.	1904 50	1904 85	......	......	1904 70	1907	1904 90	......	......	1906 75	1907 85
Chasselas × Rupestris, No. 901	1904 90	1904 90	......	......	1905 75	......	......	......	......	......	1908 ......
(Cinerea × Rupestris) × Riparia, No. 229	1905 80	1905 80	......	......	......	......	......	......	......	1906 85	1908 ......
Clairette Doré Ganzin	1903 90	1903 95	1905 100	1907	1907	1907	......	1907 75	......	......	1908 ......
Cloeta	1903 95	1903 40	......	......	1906 40	......	......	......	......	......	......
Columbaud × Riparia, No. 2502	1904 90	1904 95	......	1907	1907	1907	......	1907 95	......	1906 94	1907 85
Concord	1904 85	1904 90	1905 40	......	1904 80	1904 95	1904	1904 90	1906 90	1906 85	......
Constantia[a] (syn., *Rupestris metallica S. A.*)	1905 90	1905 95	1905 97	......	......	......	......	......	1907 85	1907 90	1907 95
Cordifolia × Riparia, No. 125-1	1904 87	1904 95	......	......	......	1907	......	1906 75	......	1906 75	......
Cordifolia × Rupestris	......	1905 80	......	1905 80	1904 60	......	......	......	......	1906 85	......
Cornucopia	1903 95	1903 75	......	......	......	1907	......	1907 75	......	1906 92	......
Couderc, No. 101	1904 90	1904 90	......	1904 96	1904 95	1904 90	1904 88	1907 75	1907 95	1907 80	1907 85
Couderc, No. 201	1904 95	1904 95	......	1904 94	1904 85	1904 95	1904 90	......	......	1907 85	1908 ......
Couderc, No. 503	1904 90	1904 95	1907	1904 85	1904 85	1904 85	1904 78	1907	1907 90	1907 93	1908 ......
Couderc, No. 704	1904 90	......	......	......	1904 80	1904 85	1904 83	......	......	......	1908 ......
Couderc, No. 3701	1904 95	1904 99	1907	......	1904 95	1904 95	1904 88	1907	1907 90	1907 95	1907 75
Couderc, No. 28 × No. 112	1904 95	1904 85	1907	1904 85	1904 95	1904 95	1904 98	1905	1907 95	1907 95	1907 80
Couderc, No. 82 × No. 32	1904 90	1904 90	......	1904 80	1904 85	1904 90	1904 82	1907 70	1907 90	1907 90	......
Couderc, No. 84 × No. 61	1904 40	1904 65	1907	1904 65	1904 70	1904 60	1904 60	1907 65	1907 85	1907 60	1907 70
Couderc, No. 87 × No. 115	1904 85	1904 95	1907	1907	1904 95	1907	1907 85	1907	1907 80	1907 92	1908 ......
Couderc, No. 124 × No. 30	1904 90	1904 70	1907	1904 87	1904 90	1904 70	1904 80	1904 98	......	1907 90	......
Couderc, No. 132-11	1907	......	......	......	......	......	......	......	......	1907	......
Cunningham	1905 75	......	1905 80	......	......	......	......	......	......	......	......
De Grasset	1903 95	1903 99	1905 80	1906 90	......	1907	......	......	1907 80	1906 90	1907 90

[a] Rupestris Metallica S. A., was introduced from South Africa, but there being another variety called Rupestris Metallica the writer has called this Constantia, after the Great Constantia Wine Farm, Cape of Good Hope, where the variety originated.

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Delaware	1904 85	1904 75	1905 80	1905 50	1904 80	1904 75	1904 30	1904 80	......	1906 75	......
Diamond	1905 60	......	1905 60	......	......	......	......	......	......	......	......
Diana	1905 90	......	1905 60	......	......	......	......	......	......	......	......
Dog Ridge	1903 95	1903 85	1905 100	1904 90	1904 95	1904 95	1904 93	1904 90	1906 95	1906 92	1907 87
Duchess	1905 90	1905 95	......	1905 70	1905 90	1905 90	1905 80	1905 95	1906 95	1906 92	......
Early Victor	1905 80	......	1905 60	......	......	......	......	......	......	1906 60	......
Elvira	1904 70	1904 90	1905 60	1907	......	......	......	1904 92	1906 80	1906 75	1907
Fenoil (syn., *Hybrid Fenoil*)	......	......	......	......	......	......	......	1904 92	......	......	......
Fern Munson	1903 90	......	......	......	1905 95	1904 90	......	......	1906 100	1906 85	......
Gamay Couderc, No. 3103	1903 95	1903 99	1905 95	1907	......	1907	......	......	1906 95	......	......
Gold Coin	1904 75	1904 85	......	1905	......	1904 90	1904 90	......	......	......	......
Golden Champion	1905 40	1905 20	......	......	......	......	......	......	......	......	......
Herbemont	1903 90	1904 95	1905 70	......	1904 85	1904 70	......	......	1906 95	1906 75	......
Herbert	1905 75	1905 90	......	......	......	......	......	......	......	1906 75	......
Hexamer (syn., *Dr. Hexamer*)	1905 90	1905 65	1905 90	......	......	......	......	......	......	......	......
Hotporup	1903 90	1903 85	......	1904 85	1904 75	1904 90	1904 90	1904 90	......	1907 92	......
Husmann	1906 90	......	......	......	......	......	......	......	......	1906 90	......
Isabella	1905 85	1905 85	1905 35	1905 65	1905 90	1905 99	1905 89	1905 95	1906 95	1906 90	......
Jaeger (syn., *Hermann Jaeger*)	1903 85	1904 80	......	1904 70	1904 65	1904 40	1904 95	1904 65	......	......	......
Jefferson	1905 75	......	......	......	......	......	......	......	......	1906 85	......
Joly	1903 90	1903 85	1907	......	1907	......	1907 90	1907 80	1906 85	1906 89	1907 90
Judge	1903 90	1903 95	1907	1907 60	1907	1907	1907 90	1907 96	1906 80	1906 90	......
Kiowa	1903 95	1906 20	......	......	......	......	......	......	......	......	......
Lampasas	1904 95	......	1907	......	......	......	......	......	......	......	......
Laussel	1904 40	1904 40	......	......	......	......	......	......	......	......	......
Lenoir	1903 95	1903 65	1905 100	1904 60	1904 80	1904 85	1904 85	1904 96	1906 99	1906 90	1907 80
Lindley	1905 90	1905 95	1905 60	......	1906 70	......	......	......	1906 85	1906 80	......
Louisiana	1903 80	1907	......	......	......	1907	......	......	......	......	......
Lukfata	1903 90	1904 85	......	......	......	......	......	1904 90	......	1907 88	......
Manito	1903 95	1904 40	......	......	1907	1907	......	......	......	1907 80	......
Marguerite	1903 95	1904 40	1905 65	......	1904 90	1904 95	1904 90	1904 65	1906 90	......	......
Martha	......	......	1905 50	......	......	......	......	......	......	......	......
Mericadel	1903 95	1905 60	......	......	1907	......	......	......	......	1906 80	......
Millardet (syn., *Hybrid Millardet*)	1905 70	1905 85	1905 95	......	......	......	......	......	......	1906 85	......
Missouri Riesling	1904 85	1904 95	......	......	......	......	......	1904 87	......	......	......

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Monticola × Riparia, No. 554	1904 90	1904 80		1904 85	1904 85	1904 85	1904 80	1904 99			1907 80
Monticola × Riparia, No. 18804	1904 80	1904 95		1905 82	1904 80	1904 80		1904 90	1906 80	1906 85	1907 70
Monticola × Riparia, No. 18808	1904 90	1904 95		1905 85	1904 75	1904 90		1904 82	1906 95	1907 87	1907 87
Monticola × Riparia, No. 18815	1904 90	1904 95		1904 95	1904 90	1904 95		1905 85	1906 95	1906 90	1908
Monticola × Rupestris	1903 90	1903 85	1905 90	1906 75	1906 50	1906 85	1906 90	1906 95	1906 90	1906 80	1907 70
Moore Diamond	1905 70	1905 65	1905 55							1906 80	
Moore Early	1905 40	1905 60		1905 40	1905 50	1905 60	1905 60	1905 60	1906 70		
Motley	1903 80	1903 90		1906 62	1904 85	1906 95	1904 85	1906 95	1906 99	1906 96	
Mourvedre × Rupestris, No. 1202	1903 99	1903 90	1905 90	1904 98	1904 88	1904 80	1904 94	1904 98	1906 100	1906 92	1907 85
Mourvedre × Rupestris, No. 1203	1906 40	1906 90		1906		1906 80	1906 90	1906 85	1907 80	1906 96	
Mrs. Munson	1905 80		1905 50								
Muench	1903 90	1904 95								1907 87	
Niagara	1905 90	1905 90		1905 70	1905 85	1905 95	1905 80	1905 92	1906 95	1906 70	
Oliatatoo	1907										
Pardes (syn., *Hybrid Pardes*)	1904 95	1904 90	1905 100	1904 60	1904 70	1904 95	1907 90	1907 90	1907 95	1906 97	1907 85
Pierce	1905 60	1905 90		1905 40	1905 80	1905 90	1905 60	1905 85			
Pinot Bouschet × Riparia, No. 3001	1904 90	1904 90				1907				1907 90	1907 85
Pinot × Rupestris, No. 1305	1904 90	1904 95	1907	1904 100	1904 94	1904 99	1904 89	1904 90	1907 95	1907 97	1907 95
Plant de Carmes	1904 75	1904 65			1904 70	1907				1907 80	
Plant de Gounay	1906 75										
Ponroy	1903 85	1903 85	1907	1907	1907			1907 85	1907 85	1906 75	1907 85
Ragan			1905 60								
Ramsey	1903 95	1903 90	1907	1907	1906 85			1907 95	1907 80	1906 90	
Rebecca	1905 75	1905 50			1905 90	1905 75	1905 78	1905 70			
Riparia à Grandes Feuilles	1903 90	1903 80	1905 96	1904 85		1904 80		1907 80		1906 85	
Riparia du Colorado	1903 70	1903 65	1907	1905 50	1904 50	1904 65	1904 70	1904 70		1906 75	
Riparia France	1904 90	1904 90	1907	1904 75		1904 85		1904 80		1906 50	1907 80
Riparia Gloire de Montpellier			1905 85						1906 90	1906 80	1907 65
Riparia Grand Glabre	1903 90	1904 80	1905 95	1904 78	1904 90	1904 85		1904 88			1907 80
Riparia Martineau	1904 90									1906 90	
Riparia Ramond	1906 70		1905 95								
Riparia Selected	1905 90										
Riparia × Berlandieri, No. 161-49	1904 95				1907				1907 90	1906 90	
Riparia × (Cordifolia × Rupestris), No. 106-8	1904 90	1904 90		1904 85	1904 70	1904 90	1904 90	1904 90	1906 90	1906 80	1907 85

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Riparia Grand Glabre × Aramon Rupestris, No. 4110	1904	1904		1904		1904		1904		1906	1908
	85	85		95		90		90			
Riparia × Rupestris, No. 101	1904	1904		1904	1904	1904	1904	1904	1906	1906	1907
	85	95		87	90	80	87	95	80	80	80
Riparia × Rupestris, No. 101-14	1904	1904	1905	1904	1904	1904	1904	1904	1906	1906	1907
	85	95	50	84	85	85	75	95	90	90	80
Riparia × Rupestris, No. 3306	1904	1904	1907	1904	1904	1904	1904	1904	1906	1906	1907
	80	95		85	87	75	99	84	85	92	92
Riparia × Rupestris, No. 3309	1903	1904	1907	1904	1904	1904	1904	1904	1906	1906	1907
	92	92		85	76	75	94	90	95	85	80
Riparia × Rupestris, No. 108-103	1905					1906	1906		1906		1907
	90					85	90		90		60
Riparia × (Rupestris × Aramon) Jaeger, No. 201	1904	1904	1907	1904	1904	1904	1904	1904	1906	1906	1907
	90	85		87	70	90	92	95	99	95	85
Riparia × Rupestris de Jaeger	1904	1904	1907			1904		1907	1906		
	90	90				90		80	90		
Riparia × Rupestris Ramond	1904	1905								1906	
	90	80								70	
Rommel	1904	1904				1907		1904		1906	1907
	90	95						70		75	
Rulander			1905								
			80								
Rupestris des Caussettes	1903	1903	1905	1904	1904	1904	1904	1904	1906	1906	1907
	95	80	95	92	85	90	87	90	99	90	75
Rupestris des Semis, No. 81-2	1904	1904		1907	1907				1906	1907	1907
	95	95							90	95	95
Rupestris Ganzin	1906									1906	
	80									85	
Rupestris le Reux	1906	1905	1905							1906	
	90	60	85							80	
Rupestris Martin	1903	1903	1905	1904	1904	1904	1904	1904	1907	1906	1907
	85	85	50	85	75	70	88	85	80	82	85
Rupestris Metallica	1903	1903	1905	1904	1904	1904	1904	1904	1906	1906	
	92	80	100	94	85	80	88	96	90	82	
Rupestris Mission	1903	1903		1904	1904	1904	1904	1904	1906	1906	1907
	78	48		85	75	60	76	80	80	90	80
Rupestris Othello	1904	1904		1907						1906	1907
	99	85								80	60
Rupestris Pillans	1905	1905	1905	1905	1905	1905	1906	1905	1906	1906	1907
	70	85	95	75	70	65	92	84	85	90	65
Rupestris St. George	1903	1903	1905	1904	1904	1904	1904	1904	1906	1906	1907
	95	95	100	95	65	85	85	95	100	95	95
Rupestris × Berlandieri, No. 219 A	1904	1904	1905	1904	1904	1904	1904	1904	1906	1906	1907
	90	70	75	87	70	80	70	85	95	90	90
Rupestris × Berlandieri, No. 301 A	1904	1904		1904	1907	1904	1904	1904	1906	1906	1907
	95	80		85		75	90	76	80	90	90
Rupestris × Berlandieri, No. 301 B	1903				1905		1904	1905	1907	1906	
	85				70		90	95		87	
Rupestris × Berlandieri, No. 301-37-152	1904	1904		1906	1907				1907	1906	
	85	90		50					80	90	
Rupestris × Chasselas Rose, No. 4401	1907								1906	1906	
									95	90	
Rupestris × Cinerea	1904	1904		1907	1907				1907		1907
	90	90							80		
Rupestris × Cordifolia, No. 107-11	1905	1905		1905	1905	1905		1905	1907	1906	
	85	70		82	70	85		85	85	80	
Rupestris × (Cordifolia × Rupestris), No. 202	1904	1904			1907	1904			1907	1907	1907
	75	75				90			90	80	95
Rupestris × (Cordifolia × Rupestris), No. 202-5		1906		1906		1906	1906	1907	1906		
		90				85	95	85	85		
Rupestris × Hybrid Azemar, No. 215	1904	1904		1904	1905	1904	1904	1904	1907	1907	
	96	80		75	70	90	70	75	80	85	
Rupestris × Petit Bouschet, No. 503				1905						1906	
				90							

TABLE XXIII.—*Resistants and direct producers in the experiment vineyards of the Bureau of Plant Industry in California, etc.*—Continued.

Variety.	Experiment vineyard.										
	Oakville.	Fresno.	Cucamonga.	Livermore.	Mountain View.	Sonoma.	Geyserville.	Lodi.	Colfax.	Chico.	Stockton.
Rupestris × Petit Bouschet Jaeger, No. 504	1904 95			1906 40		1907	1904 90			1906 87	1908
Rupestris × Riparia, No. 108-16	1904 90	1904 85				1904 75		1904 50			
R. W. Munson	1903 95	1903 95	1907	1904 60	1904 85	1904 70	1904 98	1904 75	1906 90	1906 80	1908
Salt Creek	1903 99	1903 90		1905 75	1904 80	1904 85	1904 88	1904 96	1906 80	1906 87	1907
Seibel, No. 1	1904 95	1904 85	1905 100	1904 65	1904 80	1904 90	1904 90	1904 85	1907 90	1907 90	1907 75
Seibel, No. 2	1904 85	1904 85	1905 100	1904 50	1904 80	1904 80	1904 85	1904 87	1907 85	1906 92	1907 75
Seibel, No. 14	1904 80	1906 65	1905 85				1906 80		1906	1906 99	
Seibel, No. 38										1906 85	
Seibel, No. 215	1907		1905 90							1906 92	
Shalah	1903 65							1907 98		1907 90	
Solonis Ordinaire				1904 86	1904 80		1904 70	1904 95		1907	1907 75
Solonis Robusta	1903 95	1903 95	1905 100	1904 90	1904 85	1904 95	1904 87	1904 92	1906 80	1906 87	1907 90
Solonis × (Cordifolia × Rupestris), No. 202-4	1906 50	1906 75		1906				1906 75	1907 90	1906	
Solonis × Othello		1907		1904 80	1904 87	1904 99	1904 99	1904 96	1907 90	1906 93	
Solonis × Othello, No. 1613	1903 95	1903 95	1905 100	1906 60				1907 95	1906 95	1906 92	1907 90
Solonis × Riparia, No. 1615	1904 80	1904 90				1904 75		1904 92	1906 85	1906 85	1907 70
Solonis × Riparia, No. 1616	1903 90	1904 95	1907	1904 75	1904 80	1904 80	1904 85	1907 90	1906 85	1906 84	1907 80
Taylor Narbonne	1904 75	1904 95	1907	1904 75	1904 85	1904 75	1904 96	1904 70	1907 75	1906	1907 75
Texas			1905 75								
Tisserand	1904 95	1904 85						1904 70		1906 80	
Valencia	1903 85	1903 85				1904 95		1904 90		1906 87	
Valhallah	1903 85	1903 85		1907	1907	1907				1906 75	
Vermorel	1903 85	1903 90	1907		1906 60			1907 98	1906 80	1906 85	1906
Viala	1903 85	1903 95		1904 70		1907			1907 80	1906 75	1907 85
Viala × Riparia	1904 80	1904 70		1904 70	1905 70	1904 80		1904 70			
Vitis Alexandrina	1904 90	1904 95	1905 95	1906				1906 60	1906 80		1908
Vitis candicans	1905				1904 70						
Wine King	1903 95									1907 89	
Winchell (syn., *Green Mountain*)	1905		1905 45								
Worden	1905 65	1905 80		1905 40	1905 75	1905 70	1905 75	1905 70	1906 85	1906 60	
Wyoming Red	1905 90	1905 90		1905 60	1905 65	1905 90	1905 75	1905 80		1906	
Xlnta	1903 65	1904 75								1907 85	
York × Rupestris Ganzin, No. 212	1904 90	1904 80		1904 82	1905 70			1904 85			1907 70

Besides these there are at the Oakville experiment vineyard the following varieties which were planted in the spring of 1907: Couderc, Nos. 43–06, 71–20, 71–06, 74–17, 85–113, 199–88, 4401, 241–125, 267–27, 272–60, and 1173; Castel, No. 19002; Clevener; Cythiana; and Seibel, Nos. 29, 60, 70, 78, 80, 128, 209, 334, 1004, 1020, 1070, 1077, 2010, 2033, 2044, 2056, and 2029.

The nomenclature of varieties has been brought into conformity with the code of the American Pomological Society in so far as has appeared practical.

GRAFTED VINES IN CALIFORNIA EXPERIMENT VINEYARDS.

In the spring of 1905 a number of Vinifera varieties were field-grafted on leading resistant varieties to determine the value of the resistants as graft bearers and to study the congeniality existing between the different resistant and the different Vinifera varieties. (See Pls. VI and VII.)

At Oakville 106 Vinifera varieties were grafted on Lenoir and Rupestris St. George stocks, and 10 vines on Lenoir, Rupestris St. George, Dog Ridge, Herbemont, Rupestris Martin, and Salt Creek stocks of each of the following 19 leading red and white wine varieties: Burger, Semillon, Listan (syn., *Palomino*, erroneously *Golden Chasselas*), Traminer, Green Hungarian, Sauvignon Vert, Sylvaner (syn., *Franken Riesling*), Carignane, Veltliner, Pineau de Chardonnay (syn., *Chablis*), Mission, Mataro, Cabernet Sauvignon, Valdepenas, Aramon, Petit Syrah, Mondeuse, Alicante Bouschet, and Zinfandel.

In the Fresno experiment vineyard the varieties Alexandria, Malaga, Pizzutella, Feher Szagos, Vermentino, Panariti, Pedro Ximines, Mantuo de Pilas, Mission, and Saint Laurent were grafted on regular checks, 10 vines of each variety on Lenoir, Rupestris St. George, Riparia Gloire de Montpellier, Herbemont, Salt Creek, and Dog Ridge stocks; and 43 other table-grape varieties were grafted, some on Lenoir, some on Rupestris St. George, and some on both.

Some unusual climatic conditions that occurred in connection with this work should be noted. Just before the grafting was done in the Oakville experiment vineyard heavy frosts had occurred, and several occurred while the grafting was being done. The young growth on the stocks, which was from 1 to 3 inches long, had been completely killed.

At the Fresno vineyard before the grafting was done an average growth of from 4 to 6 inches had been made by the stocks when a heavy frost occurred and damaged them severely.

It should be particularly noted that at Oakville the frosts occurred at the time of grafting, when the young growth was not over 3 inches long, whereas at Fresno the growth was 4 inches or more and the frost had occurred at least a week before the grafting.

Many interesting results were obtained from these experiments. For instance, of the 19 leading wine-grape varieties grafted in regular checks on different stocks at the Oakville experiment vineyard an average stand of 96 per cent on Dog Ridge, $89\frac{1}{2}$ per cent on Salt Creek, $74\frac{6}{10}$ per cent on Herbemont, $72\frac{1}{2}$ per cent on Lenoir, and $49\frac{1}{10}$ per cent on Rupestris St. George was obtained, and of the 10 leading varieties grafted at the Fresno experiment vineyard an average stand of 90 per cent on Dog Ridge, 80 per cent on Lenoir, 80 per cent on Salt Creek, 72 per cent on Riparia Gloire de Montpellier, 71 per cent on Herbemont, and 63 per cent on Rupestris St. George resulted.

In the springs of 1906, 1907, 1908, and 1909 the grafting experiments were extensively enlarged upon, so that there are now at Oakville 226 Vinifera varieties field-grafted on Lenoir; 122 on Rupestris St. George; 113 on Dog Ridge; 30 on Riparia × Rupestris, No. 101; 30 on Solonis × Riparia, No. 1616; 29 on Riparia × Rupestris, No. 3309; 29 on Aramon Rupestris Ganzin, No. 1; 23 on Herbemont; 20 on Salt Creek; 20 on Mourvedre × Rupestris, No. 1202; 20 on Rupestris Martin; and 18 on Taylor Narbonne. In addition, there are 63 Vinifera varieties bench-grafted on 49 various resistant stocks for nursery work.

At Fresno there are 71 Vinifera varieties field-grafted on Rupestris St. George; 28 on Dog Ridge; 32 on Riparia × Rupestris, No. 101; 34 on Solonis × Riparia, No. 1616; 30 on Mourvedre × Rupestris, No. 1202; 32 on Lenoir; 25 on Monticola × Rupestris; 10 on Riparia × Rupestris, No. 101–14; 9 on Riparia × Rupestris, No. 3306; 29 on Riparia Gloire de Montpellier; 29 on Adobe Giant; 27 on Rupestris Martin; 24 on Aramon Rupestris Ganzin, No. 1; 23 on Taylor Narbonne; 23 on Solonis Robusta; 19 on Australis; 18 on Solonis Othello; 17 on Berlandieri × Rupestris, No. 219 A; 17 on Constantia; 17 on Riparia × Rupestris, No. 3309; 14 on Viala; 16 on Salt Creek; 15 on Monticola × Riparia, No. 18804; 12 on Aramon × Rupestris Ganzin, No. 2; 13 on Monticola × Riparia, No. 18808; 13 on Hotporup; 12 on Rupestris des Caussettes; 10 on Rupestris Mission; 10 on Berlandieri × Riparia, No. 420 A; 10 on Herbemont; and 10 on Riparia × (Cordifolia × Rupestris), No. 106–8, besides smaller lots on 27 other stocks.

At Lodi a bench-grafted collection of 54 Vinifera varieties grafted on 29 various resistant varieties has been planted.

CONGENIALITY AND ADAPTABILITY OF VINES.

Two vine varieties are congenial to each other when both top and root flourish if one be grafted on the other.

The congeniality would be called perfect when a variety grafted on another behaves as if the stock were grafted with a scion of itself,

the union being perfect and the behavior of the vine the same as that of an entire ungrafted plant.

The term "congeniality" as used in this discussion is limited to the relation of Vinifera varieties to the resistant stocks upon which they are grafted. To properly discriminate between adaptability and congeniality and then to determine the congeniality, it is necessary to have the resistant varieties as well as the Vinifera varieties on their own roots growing as checks alongside of the grafted vines. If we have grafted vines of which both the stock and the scion varieties are known to be suited to the soil and climatic conditions and they do not thrive, we know congeniality is lacking.

The adaptability of varieties to soil, climatic, and other conditions can often be closely judged after comparatively short observation, but the congeniality must be determined by actual test. Without knowledge of its adaptability to the existing conditions, the extent to which differences in the behavior of a Vinifera variety grafted on different stocks are due to congeniality and to adaptability is impossible of determination.

Extensive saccharine and acid determinations of the fruit from grafted vines in the experimental vineyards have been made during two vintage seasons with a view to ascertaining whether the quality and quantity of the fruit are influenced by the stock upon which the vine is grafted. These tests have yielded very interesting and suggestive data which, when contrasted with the growth ratings of the same vines based on observations and measurements of growth during the same growing seasons, indicate that there is a close correspondence between these important chemical constituents of the fruit and the congeniality of graft and stock as determined by observation of growth. Similar ratings of the growth of a variety grafted on various stocks are found to be accompanied by fairly definite percentages of sugar and acid. Under like conditions of growth the sweetness and acidity of the fruit, as well as its time of ripening, are evidently materially influenced by the congeniality of the graft and stock. The determination of saccharine and acid contents of the fruit thus throw light on the congeniality of the graft and stock which produce it and afford a useful check on the congeniality ratings which are based on observations and measurements of vine growth, productiveness, and other important factors.

Saccharine and acid are two of the leading considerations in the money value of the fruit. In determining the relative congeniality of Vinifera varieties on diverse resistant stocks these and the relative amount of fruit produced, the difference in the time of ripening, the relative healthfulness and comparative durability of varieties on

the different stocks, and the relative amount of wood produced are some of the considerations that appear most important.

The relative ratings given the Vinifera varieties on the different resistant stocks at the Oakville and Fresno vineyards in Table XXIV show the general health and vigor of the vines under the conditions at those places. They are valuable in that where high ratings are shown the congeniality and adaptability are both good and both stock and scion are suited to existing conditions.

GROWTH RATINGS OF VINIFERA VARIETIES GRAFTED ON RESISTANT STOCKS.

In Table XXIV, following, the upper numbers after each name in the resistant stock columns show the years when the vines were grafted; the lower numbers show the growth ratings, which in each case were made in the autumn of 1908.

The growth of each variety on the different stocks in the vineyard in which it is under test is expressed in the form of a percentage rating on a scale in which the growth of the variety when not grafted but growing as an entire plant on its own root under conditions to which it is well adapted is taken as the standard of excellence, 100 per cent. These ratings, therefore, represent the behavior of each variety grafted on the several stocks under the conditions existing at the vineyard in which it is found, expressed in terms that permit comparison with its behavior when growing as an entire plant on its own roots under favorable conditions and not based on comparison with other Vinifera varieties grafted on the same stocks in the same vineyard. To illustrate: Zinfandel, grafted in the Oakville vineyard in 1905 on different resistant stocks, on Dog Ridge was rated as to growth at 95; on Lenoir, 90; on Rupestris St. George, 85; and on Solonis × Riparia, No. 1616, at 60. This shows that the Zinfandel, which is well adapted to the conditions there, when grafted on these different stocks at the same time under the same conditions in the same vineyard with the same treatment varied in growth and behavior in comparison with the variety on its own roots in accordance with the above ratings.

In Table XXIV the nomenclature of varieties has been brought into conformity with the code of the American Pomological Society in so far as has appeared practicable.

TABLE XXIV.—*Vinifera varieties grafted on resistant stocks in the Oakville and Fresno experiment vineyards of the Bureau of Plant Industry, showing the year of grafting and the growth rating.*[a]

Variety.	Vineyard.	Aramon Rupestris Ganzin, No. 1.	Adobe Giant.	Dog Ridge.	Herbemont.	Lenoir.	Mourvedre×Rupestris, No. 1202.	Rupestris St. George.	Rupestris Martin.	Riparia×Rupestris, No. 101.	Riparia×Rupestris, No. 3306.	Riparia×Rupestris, No. 3309.	Riparia Gloire.	Salt Creek.	Solonis×Riparia, No. 1616.	Taylor Narbonne.
Admirable (syn., *Admirable de Courtiller*).	Oakville	....	....	....	....	....	....	....	....	....	....	1906 80	....	....	....	....
Aleatico	Oakville	....	....	1906 95	....	1905 90	....	1905 95	....	....	....	....	....	....	....	1906 80
Alexandria (syn., *Muscat of Alexandria*).	Fresno	1906 70	1906 70	1905 85	1905 60	1905 75	1906 65	1905 80	1905 70	1906 80	....	1906 90	1905 80	1905 95	1906 70	1906 65
Alicante (syn., *Black St. Peter*).	Fresno	....	....	....	....	1905 75	....	1905 80	....	....	....	....	....	....	....	....
Alicante Bouschet	Oakville	1906 80	....	1905 85	1905 80	1905 85	1906 40	1905 85	1905 85	1906 45	....	1906 65	....	1905 80	1906 70	1906 85
Aramon	Oakville	1906 90	....	1905 95	1905 90	1905 90	1906 95	1905 90	1905 90	1906 90	....	1906 85	....	1905 85	1906 75	1906 75
Baba	Oakville	....	....	1906 90	....	1905 80	....	1905 75	....	....	....	....	....	....	....	1906 90
Bakator	Oakville	1906 85	....	1906 65	....	....	....	....	....	1906 95	....	1906 95	....	....	1906 90	1906 75
Bakator	Fresno	....	....	....	....	....	....	1905 90	....	....	....	....	....	....	....	....
Barbarossa	Oakville	....	....	1906 90	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 90
Barbarossa	Fresno	1906 95	1906 75	1906 85	....	1905 75	....	1905 90	....	....	....	1906 85	1906 65	....	1906 75	....
Barbera (syn., *Barbera Fina*).	Oakville	....	....	....	....	1905 80	....	1905 80	....	....	....	....	....	....	....	1906 75
Bastardo	Oakville	....	....	1905 85	....	1905 95	....	1905 95	....	....	....	....	....	....	....	1906 75
Béclan	Oakville	....	....	1906 90	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 85
Bellino	Oakville	....	....	1906 80	....	1905 95	....	1905 95	....	....	....	....	....	....	....	1906 85
Bellino	Fresno	1906 85	1906 75	1906 85	....	1905 80	1906 85	1905 85	....	1906 80	....	1906 80	....	....	1906 65	1906 75
Bicane (syn., *Chasselas Napoleon*).	Oakville	....	....	1905 90	....	1905 90	....	1905 90	....	....	....	....	....	....	....	....
Bicane (syn., *Chasselas Napoleon*).	Fresno	....	1906 65	....	....	....	....	1905 80	....	....	....	....	....	....	....	....
Black Kapadjulari	Oakville	....	....	1906 90	....	1906 80	....	....	....	....	....	....	....	....	....	....
Black Prince	Oakville	....	....	1906 95	....	1905 95	....	1905 90	....	....	....	....	....	....	....	1906 85
Blauer Portugieser (syn., *Portugais Bleu*).	Oakville	....	....	1906 95	....	1905 95	....	1905 90	....	....	....	....	....	....	....	....
Boal de Madère	Oakville	....	....	1906 75	....	1905 95	....	1905 95	....	....	....	....	....	....	....	1906 90
Bolynino (syn., *Nebbiolo de Dronero*).	Oakville	....	....	1906 90	....	1905 90	....	1905 95	....	....	....	....	....	....	....	1906 90
Boudales	Oakville	....	....	....	....	1905 90	....	1905 90	....	....	....	....	....	....	....	....
Buckland (syn., *Buckland Sweetwater*).	Oakville	....	....	....	....	1905 80	....	1905	....	....	....	....	....	....	....	....
Burger	Oakville	1906 80	....	1905 75	1905 65	1905 85	1906 95	1905 75	1905 85	1906 80	....	1906 90	....	1905 80	1906 60	1906 95
Cabernet Sauvignon	Oakville	1906 90	....	1905 95	1905 90	1905 90	1906 85	1905 90	1905 95	1906 85	....	1906 85	....	1905 90	1906 70	1906 70
Calabrian (syn., *Calabre*).	Fresno	....	....	....	....	1905 70	....	1905 90	....	....	....	....	1905 65	....	....	....
Calmette (syn., *Grand Noir de la Calmette*).	Oakville	1907	....	....	....	1907	....	....	....	1907	....	1907	....	....	1907	....
Carignane	Oakville	1906 85	....	1905 95	1905 90	1905 95	1906 85	1905 90	1905 90	1906 85	....	1906 95	....	1905 85	1906 80	1906 85
Chasselas Bouches du Rhone.	Oakville	....	....	1906 85	....	1905 95	....	1905 95	....	....	....	....	....	....	....	1906 75
Chasselas Bulhery	Oakville	....	....	1906 90	....	1905 90	....	1905 85	....	....	....	....	....	....	....	1906 60
Chasselas de Fontainebleau.	Fresno	....	....	....	....	....	....	1905 70	....	....	....	....	....	....	....	....
Chasselas Doré	Oakville	....	....	1906 90	....	1905 95	....	1905 90	....	....	....	....	....	....	....	....

[a] The upper figures after each name in each column show the year when the grafts were set; the lower figures show the growth rating in 1908.

Table XXIV.—*Vinifera varieties grafted on resistant stocks in the Oakville and Fresno experiment vineyards of the Bureau of Plant Industry, etc.*—Continued.

Variety.	Vineyard.	Aramon × Rupestris Ganzin, No. 1.	Adobe Giant.	Dog Ridge.	Herbemont.	Lenoir.	Mourvedre × Rupestris, No. 1202.	Rupestris St. George.	Rupestris Martin.	Riparia × Rupestris, No. 101.	Riparia × Rupestris, No. 3306.	Riparia × Rupestris, No. 3309.	Riparia Gloire.	Salt Creek.	Solonis × Riparia, No. 1616.	Taylor Narbonne.
Chasselas Duhamel	Oakville	1906 65		1906 90		1905 95		1905 90								
Chasselas Florence	Oakville			1906 90		1905 95		1905 85								1906 65
Chasselas Montauban	Oakville					1905 85		1905 90								
Chasselas Musque Vrai	Oakville			1906 90		1905 95		1905 95								
Chasselas Negrepont	Oakville			1906 90		1905 90		1905 95								1906 75
Chasselas Negrepont	Fresno							1905 70					1905 50			
Chasselas Rouge	Oakville					1905 90		1905 90								
Chasselas Rose de Falloux.	Oakville	1906 95		1906 85		1905 80	1906 95	1905 90		1906 95		1906 70			1906 70	1906 70
Chasselas Rose de Falloux.	Fresno							1905 70								
Chasselas Rose Royal	Oakville	1906 75		1906 90		1905 85		1905 85								1906 20
Chaouch	Oakville					1905										
Chauché Noir	Oakville			1906 90		1905 90		1905 95								
Charbono	Oakville			1906 95		1905 90		1905 90								1906 90
Chenin Blanc (syn., *Pineau Blanc de la Loire*).	Oakville			1906 90		1905 99		1905 90								
Cinsaut	Oakville					1905 75		1905 90								
Citronelle	Oakville					1905		1905								
Clairette Mazel	Oakville					1905		1905								
Commandeur (syn., *Le Commandeur*).	Oakville										1906 65					
Danugue	Oakville			1906 75		1905 80		1905 85								1906 90
Dodrelabi (syn., *Gros Colman*).	Oakville			1906 90		1905 90		1905 85								1906 95
Emathia	Oakville			1908		1908										
Feher Szagos	Fresno	1906 95	1906 50	1905 94	1905 65	1905 80	1906 95	1905 95	1905 60	1906 70		1906 99	1905 90	1905 85	1906 85	1906 65
Ferrara	Oakville				1908	1908				1908		1908			1908	
Fintendo	Oakville			1906 90		1905 85		1905 85								1906 75
Flame Tokay	Oakville	1907 90		1907 90		1907 90				1907		1907			1907	
Foster (syn., *Foster's Seedling*).	Fresno					1905 85		1905 80					1905 40			
Frankenthal Précoce	Oakville					1905 85		1905 90								
Gamay de Bourgogne	Oakville			1906 85		1905 90		1905 95								
Gamay Teinturier	Oakville			1906 90		1905 90		1905 90								1906 60
Golden Champion	Oakville					1905 90		1905 80								1906 85
Gradiska	Oakville			1906 90		1905 90		1905 90								1906 80
Green Hungarian	Oakville	1906 90		1905 85	1905 70	1905 90	1906 70	1905 65	1905 80	1906 90		1906 90		1905 85	1906 80	1906 65
Grenache	Oakville			1906 95		1905 95		1905 95								1906 80
Gros Verdot	Oakville			1906 85		1905 90		1905 85								1906 75
Huasco	Fresno	1905 75				1905 75	1906 80	1905 85		1906 85		1906 80	1906 65		1906 65	1906 80
Hunisa	Fresno		1906 70	1906 90												
Jura Muscat	Fresno					1905 70		1905 85					1905 80			

TABLE XXIV.—*Vinifera varieties grafted on resistant stocks in the Oakville and Fresno experiment vineyards of the Bureau of Plant Industry, etc.*—Continued.

Variety.	Vineyard.	Aramon Rupestris Ganzin, No. 1.	Adobe Giant.	Dog Ridge.	Herbemont.	Lenoir.	Mourvedre×Rupestris, No. 1202.	Rupestris St. George.	Rupestris Martin.	Riparia×Rupestris, No. 101.	Riparia×Rupestris, No. 3306.	Riparia×Rupestris, No. 3309.	Riparia Gloire.	Salt Creek.	Solonis×Riparia, No. 1616.	Taylor Narbonne.
Kadarka	Fresno	....	....	1906 95	....	1905 75	....	1905 90	....	....	....	....	1905 70	....	....	....
Kölner (syn., *Grössblauer*).	Oakville	....	....	1906 90	....	1905 80	....	1905 90	....	....	....	....	....	....	....	....
Lahntraube (syn., *Von der Lahn Traube*).	Fresno	....	....	....	....	1905 75	....	1905 70	....	....	....	....	1905 70	....	....	....
Leani Zolo	Fresno	....	....	....	....	....	....	1905 75	....	....	....	....	....	....	....	....
Lignan Blanc (syn., *Blanc Précoce de Keintzheim, Luglienga*).	Oakville	....	....	1906 75	....	1905 90	....	1905 70	....	....	....	....	....	....	....	1906 70
Listan (syn., *Palomino*, erroneously *Golden Chasselas*).	Oakville	1906 95	....	1906 85	1906 80	1905 85	1906 99	1905 90	1906 90	1906 95	....	1906 90	....	1906 80	1906 80	1906 95
Luglienga Nera	Fresno	1906 90	1906 65	1906 90	....	1905 70	1906 85	1905 80	....	1906 80	....	1906 75	1905 65	....	1906 65	1906 70
Madeleine Angevine	Oakville	....	....	1905 75	....	1905 90	....	1905 90	....	....	....	....	....	....	....	....
Madeleine d'Ambre (syn., *Madeleine Blanche d'Ambre*).	Oakville	....	....	1906 90	....	1905 95	....	1905 90	....	....	....	....	....	....	....	....
Madeleine de Jacques (syn., *Madeleine Blanche de Jacques*).	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
Madeleine Rose	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
Madeleine Royale	Oakville	....	....	1906 85	....	1905 80	....	1905 85	....	....	1906 80	....	....	....	....	....
Malaga	Fresno	1906 92	1906 85	1905 99	1905 60	1905 80	1906 95	1905 95	1905 70	1906 90	....	1906 85	1905 95	1905 85	1906 75	1906 80
Malaga Blanc	Fresno	....	....	....	....	1905 65	....	1905 90	....	....	....	....	1905 85	....	....	....
Malvasia Rosaria	Fresno	....	....	1906 85	....	1905 75	....	1905 90	....	....	....	....	1905 85	....	....	....
Mamelon	Oakville	....	....	1906 90	....	1905 90	....	1905 95	....	....	....	....	....	....	....	1906 85
Mantuo de Pilas	Fresno	1906 95	1906 70	1905 80	1905 70	1905 70	1906 90	1905 90	1905 75	1906 85	....	1906 95	1905 90	1905 80	1906 85	1906 70
Marmora (syn., *General de la Marmora*).	Fresno	....	....	....	....	1905 80	....	1905 80	....	....	....	....	1905 60	....	....	....
Mataro	Oakville	1906 90	....	1905 95	1905 80	1905 90	1906 90	1905 90	1905 85	1906 90	....	1906 95	....	1906 85	1906 80	1906 80
Melon (syn., *Olivier de Serres*).	Fresno	....	....	1906 85	....	....	....	1905 85	....	....	....	....	....	....	....	....
Meunier	Oakville	....	....	1906 90	....	1905 95	....	1905 90	....	....	....	....	....	....	....	....
Meslier (syn., *Meslier Hatif*).	Oakville	1906 90	....	....	....	1905 90	....	1905 85	....	....	....	....	....	....	....	....
Meyer, No. 59	Oakville	....	....	1906 90	....	1906 90	....	....	....	....	....	....	....	....	....	....
Meyer, No. 60	Oakville	....	....	1906 95	....	1906 90	....	....	....	....	....	....	....	....	....	....
Meyer, No. 95	Oakville	....	....	1906 95	....	1906 95	....	....	....	....	....	....	....	....	....	....
Meyer, No. 116	Oakville	....	....	1906 90	....	1906 90	....	....	....	....	....	....	....	....	....	....
Millenium (syn., *Hungarian Millenium*).	Oakville	1907	....	....	....	1906 90	....	....	....	1907	....	1907	....	....	1907	....
Mission	Oakville	....	....	1905 95	1905 90	1905 95	....	1905 95	1905 90	....	....	....	....	1905 85	....	....
Mission	Fresno	....	1906 85	1905 85	1905 80	1905 70	....	1905 85	1905 80	....	....	....	1905 80	1905 85	....	....
Mondeuse	Oakville	1906 90	....	1905 95	1905 80	1905 95	1906 90	1905 90	1905 80	1906 85	....	1906 90	....	1905 85	1906 75	1906 80
Mourastel	Oakville	1906 90	....	1906 90	....	....	1906 80	....	....	1906 90	....	1906 90	....	....	1906 70	1906 80
Mourisco Bianca	Oakville	....	....	1906 90	....	1905 90	....	1905 95	....	....	....	....	....	....	....	1906 85
Mourisco Preto	Oakville	....	....	1906 85	....	1905 95	....	1905 95	....	....	....	....	....	....	....	....
Muscadelle du Bordelais (syn., *Musquette*).	Fresno	1906 90	1906 65	....	....	1905 80	1906 90	1905 85	....	1906 85	....	1906 90	1905 65	....	1906 65	1906 65

TABLE XXIV.—*Vinifera varieties grafted on resistant stocks in the Oakville and Fresno experiment vineyards of the Bureau of Plant Industry, etc.*—Continued.

Variety.	Vineyard.	Aramon Rupestris Ganzin, No. 1.	Adobe Giant.	Dog Ridge.	Herbemont.	Lenoir.	Mourvedre×Rupestris, No. 1202.	Rupestris St. George.	Rupestris Martin.	Riparia×Rupestris, No. 101.	Riparia×Rupestris, No. 3306.	Riparia×Rupestris, No. 3309.	Riparia Gloire.	Salt Creek.	Solonis×Riparia, No. 1616.	Taylor Narbonne.
Muscat Albardiens	Fresno	1906 80	....	....	....	1905 80	1906 90	1905 85	....	1906 75	....	1906 90	1905 60	....	1906 70	1906 65
Muscat Capusines	Oakville	....	....	1906 70	....	1905 80	....	1905 90	....	....	....	....	....	....	....	....
Muscat Gros Noir Hatif	Oakville	....	....	1906 90	....	1905 70	....	1905 80	....	....	....	....	....	....	....	1906 75
Muscat Hamburgh	Oakville	....	....	....	....	1905 85	....	1905 90	....	....	....	....	....	....	....	1906 80
Muscat Noir d'Hongrie	Oakville	....	....	....	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 85
Muscat Noir Précoce	Oakville	....	....	1906 75	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 85
Muscat Rouge de Madère (syn., *Muscat Madère Rose*).	Fresno	....	....	....	....	1905 65	....	1905 85	....	....	....	....	1905 85	....	....	....
Muscat Talabot (syn., *Clairette Musquée Talabot*).	Oakville	....	....	....	....	1906 85	....	1906 80	....	....	....	....	....	....	....	....
Muscateller (syn., *White Frontignan*).	Fresno	....	....	1906 70	....	1905 80	....	1905 85	....	....	....	....	1905 50	....	....	....
Nebbiolo (syn., *Spana*)	Oakville	....	....	1905 50	....	1905 90	....	....	....	....	....	....	....	....	....	1906 65
Nebbiolo Bourgu	Oakville	....	....	1906 90	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 50
Nebbiolo Fino	Oakville	....	....	1906 90	....	1905 85	....	1905 85	....	....	....	....	....	....	....	1906 70
Pagadebito	Oakville	....	....	1906 95	....	1905 95	....	1905 95	....	....	....	....	....	....	....	1906 75
Panariti	Fresno	1906 90	1906 85	1905 90	1905 65	1905 70	1906 75	1905 95	1905 65	1906 70	....	1906 90	1905 90	1905 90	1906 80	1906 65
Parc de Versailles	Fresno	1906 95	1906 70	1906 87	....	1905 80	1906 40	1905 85	....	1906 30	....	1906 75	1905 65	....	1906 65	1906 85
Pedro Ximines	Fresno	1906 75	1906 70	1905 85	1905 80	1905 70	1906 95	1905 85	1906 85	1906 90	....	1906 99	1905 80	1905 80	1906 85	1906 85
Perle Blanche	Oakville	....	....	....	....	1905 90	....	1905 85	....	....	....	....	....	....	....	....
Peru (syn., *Rose of Peru*).	Oakville	....	....	....	....	1909	....	1909	....	....	....	....	....	....	....	....
Petit St. Jean	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
Petit Syrah	Oakville	1906 80	....	1905 95	1905 80	1905 80	....	1905 90	1905 90	1906 80	....	1906 75	....	1905 85	1906 70	1906 80
Petit Verdot	Oakville	....	....	1906 90	....	1905 95	....	1905 85	....	....	....	....	....	....	....	1906 70
Peverella	Oakville	....	....	1906 85	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 85
Pineau de Chardonnay	Oakville	1906 85	....	1905 95	1905 75	1905 90	1906 85	1905 90	1905 90	1906 80	....	1906 90	....	1905 85	1906 65	1906 80
Pineau de Ribeauvillers	Oakville	....	....	1906 90	....	1905 80	....	1905 85	....	....	....	....	....	....	....	....
Pineau Noir Epernay	Oakville	....	....	....	....	1905 80	....	1905 85	....	....	....	....	....	....	....	....
Pinot St. George	Oakville	....	....	1905 95	....	1906 90	....	1905 95	....	....	....	....	....	....	....	....
Pis de Chevre des Alps	Oakville	....	....	1906 90	....	1905 95	....	1905 90	....	....	....	....	....	....	....	....
Pizzutella (syn., *Pizzutella di Roma*).	Fresno	1906 90	1906 80	1905 60	1905 60	1905 80	1906 75	1905 95	1905 65	1906 99	....	1906 95	1905 85	1905 65	1906 90	1906 50
Precoce de Courtiller	Oakville	....	....	....	....	1905 70	....	1905 85	....	....	....	....	....	....	....	....
Purple Damascus	Fresno	1906 90	1906 70	1906 90	....	1905 85	1906 95	1905 90	....	1906 80	....	1906 90	1906 70	....	1906 70	1906 75
Quagliano	Oakville	....	....	1906 70	....	1905 85	....	1905 80	....	....	....	....	....	....	....	1906 90
Razaki Zolo	Fresno	....	....	....	....	....	....	1905	....	....	....	....	....	....	....	....
Red Hanepoot	Oakville	1907	....	....	....	....	....	....	....	1907	....	....	....	....	....	....
Refosco	Oakville	....	....	1906 90	....	1905 90	....	1905 90	....	....	....	....	....	....	....	1906 90
Ribier (syn., *Gros Ribier*)	Oakville	....	....	....	....	1905 90	....	1905 90	....	....	....	....	....	....	....	....
Rodites	Oakville	....	....	....	....	1907 95	....	1907 95	....	....	....	....	....	....	....	....

TABLE XXIV.—*Vinifera varieties grafted on resistant stocks in the Oakville and Fresno experiment vineyards of the Bureau of Plant Industry, etc.*—Continued.

Variety.	Vineyard.	Aramon Rupestris Ganzin, No. 1.	Adobe Giant.	Dog Ridge.	Herbemont.	Lenoir.	Mourvedre×Rupestris No. 1202.	Rupestris St. George.	Rupestris Martin.	Riparia×Rupestris, No. 101.	Riparia×Rupestris, No. 3306.	Riparia×Rupestris, No. 3309.	Riparia Gloire.	Salt Creek.	Solonis×Riparia, No. 1616.	Taylor Narbonne.
Rose d'Italie	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	....	....	85	....	90	....	....	....	....	....	....	....	....
Roussaou	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	95	....	85	....	80	....	....	....	....	....	....	....	70
Saint Laurent (syn., *Muscat St. Laurent*).	Fresno	1906	1906	1905	1905	1905	1906	1905	1905	1906	....	1906	1905	1905	1906	1906
		90	70	65	70	65	90	90	70	85	....	75	70	75	65	30
St. Macaire	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	95	....	90	....	....	....	....	....	....	....	85
San Gioveto	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	85	....	90	....	85	....	....	....	....	....	....	....	75
Satin Blanc	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	....	....	95	....	90	....	....	....	....	....	....	....	....
Sauvignon Blanc	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	90	....	90	....	85	....	....	....	....	....	....	....	....
Sauvignon Vert	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1905	1906	1906
		95	....	90	90	90	90	80	90	95	....	95	....	90	85	85
Semillon	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1905	1906	1906
		75	....	85	95	90	80	70	80	70	....	70	....	80	70	70
Serine (syn., *Syrah de l'Ermitage*).	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	85	....	90	....	95	....	....	....	....	....	....	....	65
Sicilien (syn., *Panse Précoce*).	Oakville	1906	....	....	....	1907	....	....	....	....	....	....	....	....	....	....
		70	....	....	....	90	....	....	....	....	....	....	....	....	....	....
Souvenir du Congrès	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	....	....	95	....	....	....	....	....	....	....	....	....	....
Sucre de Marseille	Oakville	....	....	1905	....	1905	....	....	....	....	....	....	....	....	....	1906
		....	....	90	....	90	....	....	....	....	....	....	....	....	....	75
Sultanina (syn. erroneously, *Thompson Seedless*).	Oakville	1907	....	1907	....	1907	....	....	....	1907	....	1907	....	....	1907	....
Sultanina Rosea	Oakville	1907	....	....	....	1907	....	....	....	1907	....	....	....	....	1907	....
Sylvaner (syn., *Franken Riesling*).	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1905	1906	1906
		90	....	90	95	90	85	75	80	90	....	70	....	85	90	90
Tadone	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	85	....	85	....	....	....	....	....	....	....	70
Tannat	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	80	....	95	....	....	....	....	....	....	....	70
Tinta Amarella	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	95	....	95	....	95	....	....	....	....	....	....	....	85
Tinta Cão	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	95	....	95	....	90	....	....	....	....	....	....	....	85
Tinta de Madeira	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	95	....	95	....	....	....	....	....	....	....	60
Traminer	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1905	1906	1906
		80	....	75	70	90	65	90	80	65	....	90	....	80	70	90
Trentham (syn., *Trentham Black, Long Noir d'Espagne*).	Oakville	....	....	....	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	....	....	95	....	85	....	....	....	....	....	....	....	....
Trousseau	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	95	....	95	....	....	....	....	....	....	....	85
Tsien Tsien	Oakville	....	....	....	1908	1908	....	....	....	....	....	1908	....	....	1908	1908
Valandova	Oakville	....	....	1906	....	1906	....	....	....	....	....	....	....	....	....	....
		....	....	90	....	90	....	....	....	....	....	....	....	....	....	....
Valdepenas	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1906	1906	1906
		90	....	95	95	95	95	95	90	90	....	85	....	85	60	70
Veltliner	Oakville	....	....	1905	1905	1905	....	1905	1905	....	....	....	....	1905	....	....
		....	....	90	80	90	....	75	85	....	....	....	....	90	....	....
Verdal (syn., *Servant*)	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	1906
		....	....	90	....	99	....	90	....	....	....	....	....	....	....	75
Verdelho de Madère	Fresno	1906	....	1906	....	....	....	1905	....	....	....	1906	....	....	1906	1906
		70	....	60	....	....	....	85	....	....	....	65	....	....	60	50
Vermentino (syn., *Malmsey*).	Fresno	1906	1906	1905	1905	1905	1906	1905	1905	1906	....	1906	1905	1905	1906	1906
		80	75	85	70	70	75	95	65	65	....	95	85	80	95	75
White Hanepoot	Fresno	1906	1906	1906	....	1906	1906	1906	....	1906	....	1906	....	....	1906	1906
		65	75	83	....	85	85	80	....	70	....	85	....	....	70	70
Wilmot, No. 16	Oakville	....	....	1906	....	1905	....	1905	....	....	....	....	....	....	....	....
		....	....	85	....	90	....	75	....	....	....	....	....	....	....	....
Zinfandel	Oakville	1906	....	1905	1905	1905	1906	1905	1905	1906	....	1906	....	1905	1906	1906
		90	....	95	65	90	95	85	85	90	....	90	....	75	60	70

The following is an alphabetically arranged list of varieties grafted in the Oakville experiment vineyard on Lenoir stocks only; following each name the growth rating of the variety for 1908 is given:

Grafted during the spring of 1906.—Kabbajuk, 75; Kandihar, 75; Key, 90; Meyer, No. 65, 95; Meyer, No. 103, 90; Meyer, No. 107, 95; Meyer, No. 515, 85; and White Kapadjulari, 80.

Grafted during the spring of 1907.—Actoni Maceron, 85; Actoniky, 90; Ahmeur bou Ahmeur, 75; Aneb el Cadi, 85; Angelino, 85; Augulato, 80; Barducci, 80; Bicane (syn., *Chasselas Napoleon*), 90; Blanc d'Ambre, 80; Brustiano, 90; Buccleuch (*Duchess of Buccleuch*), 80; Calabrian (syn., *Calabre*), 85; Chaouch, 85; Chaouch Rose, 90; Chasselas St. Bernard, 85; Child of Hall, 90; Clairette à Gros Grain, 90; Coarna Neagra, 85; Corinthe à Gros Grain, 90; Corinthe Rose, 80; Coristano, 80; Dronkane, 90; Fajoumi Jaune, 75; Faphly, 90; Feher-Som, 85; Fredericton, 80; Gros Blanc de Lausanne, 90; Hebron, 90; Hycales, 90; Inzolia Bianca, 80; Kakour, 90; Kechmish-Aly-Blanc, 90; Keropodia, 90; Kuristi Mici, 85; Maraville de Malaga, 85; Molinera Gorda, 80; Muscat Bonod, 80; Olivette Blanche (syn., *Olivette Vendemian*), 85; Olivette Chaptal, 80; Olivette Noir (syn., *Malakoff Isjum*), 80; Olivette Rose, 90; Opiman, 80; Perle Imperial Blanche, 80; Piment, 90; Prune de Cazouls, 85; Schiradzouli Blanc, 75; Schiradzouli Violet, 85; Servan Rose, 75; Teneron, 85; Terret Monstre, 90; Trifere du Japon, 85; Triomphe, 90; Vigne de Zericho, 85.

Grafted during the spring of 1908.—Almeria, Emathia, Sultanina Rosea.

Grafted during the spring of 1909.—Ajmi, Blaney White, Buhirzi, Chadeh-Arabieh, Chaweesh, Deis-el-A'anze, Erz Roumli, Golden Hamburg, Golden Queen, Kishmishi, Kurdi, White Corinth.

LIST OF VINIFERA VARIETIES ON THEIR OWN ROOTS AT THE CUCAMONGA EXPERIMENT VINEYARD.

The following is an alphabetically arranged list of Vinifera varieties in the Cucamonga experiment vineyard, showing the years in which they were planted and their relative growth ratings:

Plantings made in 1904.—Affenthaler, 85; Alexandria (syn., *Muscat of Alexandria*), 85; Aleatico, 95; Alicante Bouschet, 100; Almeria, 100; Antibo, 70; Askari, 80; Aspiran Noir, 95; Bakator, 95; Barbarossa, 85; Barbarossa Finnebourgo, 80; Barbera (syn., *Barbera Fina*), 75; Baba, 100; Bastardo, 95; Béclan, 95; Bellino, 90; Bermestia Ciolacea, 75; Black Corinth, 95; Black Morocco, 85; Black Muscat, 90; Black Prince, 100; Black Shahanee, 95; Black Zante, 100; Blauer Portugieser, 90; Boal de Madère, 100; Boglich 85; Bolynino, 95; Bonarda, 75; Bowood Muscat, 75; Burger (syn., *White Tokay*), 100; Carignane, 100; Catarratto à la Porta, 90;

Chaouch, 75; Chasselas Rose, 85; Chauché Noir, 95; Chavooschee, 75; Cinsaut, 100; Cipro Nero, 85; Clairette Blanche, 85; Colutum Cucco Bitundo, 95; Corbeau Noir Shar, 80; Cornichon (syn., *Purple Cornichon*), 100; Croetto, 90; Crujidero, 95; Danugue, 95; Dernekusa, 90; Dizmar, 90; Dodrelabi (syn., *Gros Colman*), 100; Emperor, 85; Erbaluce di Caluso, 70; Etraire de l'Adhui, 80; Feher Goher Noir, 100; Franc Pinot, 75; Fresa de Monferat, 75; Flame Tokay, 100; Gamay Teinturier, 90; Golden Champion, 65; Green Hungarian, 95; Grenache, 100; Gros Manzenc, 80; Huasco, 95; Hutab, 80; Johannisberger, 85; Kadarka, 95; Kahallilee, 85; Kleinburger, 75; Kölner (syns., *Grössblauer* and *Blauer Lager*), 87; Kurtelaska, 80; Lignan (syn., *Madeleine Blanche*), 90; Listan (syn., *Palomino*), 100; Luglienga, 60; Macunier, 50; Madeleine Royale, 60; Malaga, 100; Malbeck, 85; Malvasia, 100; Malvasia de Broglio, 90; Malvasia Rosario, 90; Malvasia Rovasenda, 80; Mantuo de Pilas, 100; Marmola Tobead, 75; Marsanne, 75; Marzemino, 80; Merlot, 85; Mission, 100; Mondeuse, 80; Moneca Nero, 95; Mourastel, 85; Mourisco Bianca, 100; Mourisco Preto, 100; Muscateller, 95; Napoleon, 85; Nebbiolo, 75; Negrara di Gattinara (syn., *Neagra di Satinera*), 90; Negro Amaro (syn., *Neagra Amara*), 100; Neiretta di Costilla, 80; Neiretta Grosse, 70; Ocru di Boe, 85; Orleans (syn., *Orleans Riesling*), 75; Pagadebito, 95; Palarusa, 90; Paykanee Razukee, 75; Pedro Ximines, 100; Perruno, 100; Persian (no number), 85; Persian (no tag), 75; Persian No. 21, 85; Persian No. 23, 85; Persian No. 25, 80; Persian No. 26, 90; Petit Verdot, 85; Peverella, 95; Picpoul, 95; Pinot Blanc, 80; Pineau de Chardonnay, 80; Pinot St. George, 90; Pinot Vert Doré, 90; Pis de Chevre des Alps, 90; Pizzutella, 100; Poulsard (syn., *Ploussard*), 90; Purple Damascus, 95; Quagliano, 100; Refosco, 85; Robin Noir, 95; Rothgipfler, 95; Rulander, 70; St. Macaire, 80; San Gioveto, 100; Sauvignon Vert, 100; Semillon, 90; Serine, 85; Shiraz, 85; Slankamenka, 85; Spana, 90; Sultana, 70; Sultanina (syn. erroneously, *Thompson Seedless*), 90; Sylvaner (syn., *Franken Riesling*), 100; Syrian, 75; Tannat, 90; Teneron (syn., *Olivette de Cadenet*), 95; Tinta Amarella, 100; Tinta Cão, 100; Tinta de Madeira, 95; Torock Goher Noir, 100; Trentham, 85; Trivoti, 90; Trojka; Trousseau, 100; Ugava, 50; Valdepenas, 95; Veltliner (syn., *Grüner Veltliner*), 95; Verdal, 100; Verdelho, 95; Vermentino (syn., *Malmsey*), 95; Vernaccia Sarda, 90; Wälschriesling, 80; Werme, 75; Zabalkanski, 100; Zante, 100; Zinzillosa, 90.

Plantings made in 1905.—Alexandria (syn., *Muscat of Alexandria*), 80; Alicante (syn., *Alicante Noir*), 85; Ambari, 80; Barbarossa, 80; Bicane, 70; Black Hamburg (syn., *Pope Hamburg*), 75; Buckland (syn., *Buckland Sweetwater*), 40; Calabrian (syn., *Calabre*), 90; Chaouch, 95; Chasselas Bouches du Rhone, 60; Chasselas Doré, 100;

Chasselas Florence, 80; Chasselas Montauban, 55; Chasselas Negrepont, 80; Chasselas Rose de Falloux, 85; Chasselas Rouge, 80; Chenin Blanc (syn., *Pineau blanc de la Loire*), 95; Cinsaut, 95; Clairette Mazel, 80; Cornichon (syn., *Cornichon Violet*), 50; Diamant (syn., *Diamant Traube*), 40; Dodrelabi (syn., *Gros Colman*), 65; Duc de Malakoff, 95; Foster (syn., *Foster's Seedling*), 90; Frankenthal Précoce, 75; Golden Champion, 90; Gros Maroc, 90; Imperial, 95; Jura Muscat, 90; Kadarka, 40; Lignan (syn., *Précoce de Keintzheim*), 55; Listan, 100; Luglienga, 90; Madeleine Angevine, 90; Madeleine Blanche, 90; Madeleine Rose, 85; Mantuo de Pilas, 95; Marascina, 90; Marmora (syn., *General de la Marmora*), 90; Melon (syn., *Olivier des Serres*), 50; Meslier (syn., *Meslier Hatif*), 85; Meunier (syn., *Pinot Meunier*), 70; Muscat Albardiens, 90; Muscat Capusines, 90; Muscat Gros Noir Hatif, 90; Muscat Hamburg, 95; Muscat Hamburg Noir d'Hongrie, 90; Muscat Talabot (syn., *Clairette Musquée Talabot*), 65; Muscateller (syn., *Muscat de Frontignan*), 70; Nasa Valentiana, 62; Noir Hatif de Marseille, 80; Olivette Rose, 60; Peru (syn., *Rose of Peru*), 50; Pince Muscat (syn., *Mrs. Pince's Black Muscat*), 85; Pineau de Chardonnay, 80; Pineau Noir (syn., *Pineau de Ribeauvillers*), 85; Pinot Noir Epernay, 80; Pizzutella, 95; Purple Damascus, 95; Razaki Zolo, 95; Red Kishmish; Roussaou, 85; Royal Ascot, 90; Saint Laurent (syn., *Muscat St. Laurent*), 75; Semillon Blanc, 85; Serine, 85; Servan Blanc, 95; Shirshira, 80; Sicilien, 50; Teneron (syn., *Olivette de Cadenet*), 90; Trentham (syn., *Trentham Black*), 70; Tschausch, 85; Ulliade Blanche d'Ambre, 60; Venn (syn., *Venn's Black Muscat*), 85; Verdal, 100; Vermentino, 70; White Tokay, 90; Wilmot Hamburg; Wilmot, No. 16, 80.

Plantings made in 1907.—Bolynino (syn., *Nebbiolo di Dronero*), Boudales, Cabernet Sauvignon, Charbono, Chasselas Bulhery, Chasselas Cioutat, Chasselas Musque Vrai, Crabbs Burgundy, Deacon Superb, Fintendo, Gamay de Bourgogne, Gradiska, Listan (syn., *Palomino*, erroneously *Golden Chasselas*), Mamelon, Mataro, Meunier, Mourisco Bianca, Petit Syrah, Sauvignon Blanc, Serine (syn., *Syrah de l'Ermitage*), Traminer, Valdepenas, Veltliner, Zinfandel.

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ACREAGE IN THE CALIFORNIA EXPERIMENT VINEYARDS.

With the additional plantings and grafting of the springs of 1908 and 1909 the California experiment vineyards now comprise the following areas:

TABLE XXV.—*Size of California experiment vineyards and number of vines planted in each.*

Vineyard.	Acreage.	Number of resistant and direct-producing varieties.	Number of Vinifera varieties on own roots.	Number of Vinifera varieties grafted on resistant stocks.
Oakville[a]	15.75	255		247
Fresno	9.50	168		137
Cucamonga	10	84	304	
Lodi	3	113		54
Colfax	2.60	105		
Geyserville	1	91		
Livermore	1.40	112		
Mountain View	1.83⅓	128		
Sonoma	1.75	122		
Stockton	1.25	93		
Chico	1	157		

[a] At Oakville there are also 28 assorted varieties grafted on resistant stocks.

These experiment vineyards on the Pacific coast contain 415 Vinifera and 277 resistant and direct-producing varieties.

DISTRIBUTION OF VINES AND CUTTINGS.

For the double purpose of arousing an interest in viticultural research work and to have tested and to secure data on the behavior of varieties on more diverse soils and under more varying conditions, climatic and otherwise, than it would be possible to establish vineyards on, the Bureau of Plant Industry has from time to time distributed vines and cuttings to individuals, corporations, colleges, and experiment stations desiring them and expressing willingness to report on soil and other conditions, including the treatment given and the results obtained. In the winter of 1906–7 there were sent to 34 persons cuttings from an assortment of 110 resistants, and to 49 persons cuttings from 166 Vinifera varieties. In the winter of 1907–8 vines from an assortment of 72 Vinifera varieties grafted on 33 different resistant stocks were sent to 3 persons, selections from an assortment of 96 rooted resistant varieties to 7 persons, and cuttings selected from 110 Vinifera varieties to 37 persons and from 48 resistant varieties to 48 persons. In the winter of 1908–9 selections from 169 rooted resistant varieties were sent to 20 persons, and from an assortment of cuttings of 142 Vinifera varieties to 75 persons, and from 36 resistant varieties to 16 persons. It is hoped that in this way the value of varieties for special localities will be demonstrated, although in this country conditions are not yet favorable for specialization to

the same degree that they are in Europe, where, for instance, wine made from Johannisberg grapes grown on the hillside at Schloss Johannisberg has been pronounced so far superior to that from the same variety grown elsewhere that it is contracted for long before it is made. The writer recalls instances in California of varieties grown at one place being so different at another as to appear to be distinct varieties. Thus, the Zinfandel when grown on valley soil makes an ordinary wine, but when grown on hillside locations specially suited to it, though possibly not a mile distant, it makes a superior red wine. In this connection attention is called to a number of promising varieties fruiting in the California experiment vineyards of the Bureau of Plant Industry. A number of these are heavy, reliable bearers having fruit of superior quality that merit being extensively grown. Some of these have proved and others no doubt would prove better suited for large areas that are now being planted in vines than some of the varieties that are now so extensively used.

RESISTANT STOCKS GROUPED ACCORDING TO SOIL ADAPTABILITY AS INDICATED BY THEIR USE IN FOREIGN COUNTRIES.

Some of the resistant varieties have been so long and extensively tried in vine countries for resistance to phylloxera that their use in certain soil types and under certain conditions has become general. They are adapted to a greater or less degree to similar soils in the United States.

Riparia; Cordifolia; Mourvedre × Rupestris, No. 1202; Riparia × Rupestris, No. 101; Riparia × Rupestris, No. 3306; Aramon × Rupestris Ganzin, No. 1; Riparia Gloire; and Riparia à Grandes Feuilles are adapted to deep, cool, fertile, clay siliceous or alluvial soils:

Solonis × Riparia, No. 1616; Aramon × Rupestris Ganzin, No. 1; Mourvedre × Rupestris, No. 1202; Berlandieri × Riparia, No. 420 A; Riparia × Rupestris, No. 3306; Riparia × (Cordifolia × Rupestris), No. 106–8; and Solonis × (Cordifolia × Rupestris), No. 202–4, do well on rather moist lands not of the first quality.

Solonis × Riparia, No. 1616; Solonis × Othello; Champini; Salt Creek; and Riparia × Rupestris, No. 3306, are suitable for planting on alkali or occasionally flooded bottom lands.

Bourisquou × Rupestris, No. 601; Riparia × Rupestris, No. 3306; Riparia × Rupestris, No. 101–14; Mourvedre × Rupestris, No. 1202; and Aramon × Rupestris Ganzin, No. 2, are adapted to heavy clays.

Berlandieri × Riparia, No. 420 A; Berlandieri × Riparia, No. 157–11; Riparia × Rupestris, No. 3306; Bourisquou × Rupestris, No. 601; Bourisquou × Rupestris, No. 603; and Champini are suited to deep clays in warm situations.

Champini; Rupestris St. George; Rupestris Martin; Rupestris Metallica; Aramon × Rupestris Ganzin, No. 2; Berlandieri × Rupestris, No. 219 A; Berlandieri × Rupestris, No. 301 A; Monticola × Rupestris; Riparia × Rupestris, No. 3309; and Riparia × (Cordifolia × Rupestris), No. 106–8, are adapted to drier soils.

Berlandieri; Monticola; Berlandieri × Rupestris, No. 219 A; and Monticola × Rupestris are suited to dry, limy, hot locations.

Monticola; Berlandieri; Champini; Candicans; Berlandieri × Riparia, No. 157–11; and Berlandieri × Riparia, No. 420 A, are suited to arid regions and to decomposed rock and gravelly soils.

Champini; Rupestris St. George; Riparia × Rupestris, No. 3309; Mourvedre × Rupestris, No. 1202; Rupestris Martin; and Bourisquou × Rupestris, No. 603, are suited to poor, loose, deep, gravelly soils.

SOME IMPORTANT RESULTS ALREADY ACCOMPLISHED.

The experiment vineyards contain 415 Vinifera varieties, 271 of which are grafted on various resistant stocks. They also contain 277 resistant stock varieties.

The phylloxera has been placed (see Pl. V, fig. 3) on the roots of checks of all the resistant varieties to determine their resistant ratings.

Extensive nursery experiments (see Pl. VII, fig. 1) in grafting and testing the relative rooting qualities of the resistant varieties to determine their commercial value as stocks are being pursued. Records of the starting, blossoming, yield, and defoliation of all of the varieties are being made. Plants of each of the resistant and direct-producing varieties have been and will be systematically inoculated with phylloxera (see Pl. V, fig. 3) to ascertain their individual resistant qualities. Much information has been obtained about the varieties that are resistant and the varieties that should and those that should not be used in the different soils and localities (see Pl. III) under varying conditions. The stocks congenial (see Pl. V, fig. 6) to the Vinifera varieties are rapidly being ascertained. The specific and relative value of already known as well as of newly introduced varieties for the different commercial purposes are being determined. The best methods of pruning, training, grafting, culture, etc., of the varieties under the different environments are being determined.

Detailed vine descriptions are being made as rapidly as possible. Of the varieties in the experiment vineyards vine photographs of 45 varieties and root photographs of 47 varieties have been taken. Fruit descriptions of 340 varieties and photographic and other illustrations of the fruit of 73 varieties have been made; authenticated

seed samples of 272 varieties have been collected; and nearly 2,000 acid and saccharine determinations have been made. To make the results obtained in the experiment vineyards as applicable as possible to other localities, rainfall and temperatures in them are recorded, and in cooperation with the Bureau of Soils mechanical analyses and correlation of the soils in each have been made and a soil survey of the viticultural areas of California begun.

To encourage and stimulate others to research work and to gain additional information ourselves, distributions of vines and cuttings to persons in different parts of the country desiring them and willing to report to us their results have been made. Quite an extensive number of collaborators have thus been secured, and the researches are gradually extending to all those parts of the United States where Vinifera grape culture on a commercial scale is possible.

CONCLUSIONS AND SUGGESTIONS.

Diversity in soil, climatic, and other conditions makes the establishing of vineyards on resistant stocks a much more complicated problem than if these differences were less numerous.

The congeniality of the Vinifera variety to the stock on which it is grafted very materially affects the resistant quality of the stock.

The more favorable the soil, climatic, and other conditions for both scion and stock the better the plant; the more unfavorable the conditions the poorer the plant.

The adaptability of varieties to soil, climatic, and other conditions can often be closely forecasted, but congeniality has to be determined by actual test.

When both stock and scion are suited to the conditions, but will not thrive when grafted, congeniality is lacking.

Where conditions are not suited for any single species, they often are for hybrids of species.

Quantity and quality of product are often in opposition. On soils yielding most and from vines producing most the fruit is frequently of comparatively inferior quality.

The ideal characters are the most resistant root, a top producing the finest fruit of sufficient quantity, and perfect congeniality between the top and the root.

Experiments made to date in the United States and other countries show that most Vinifera varieties, when grafted and growing well on resistant stocks, yield heavier crops than ungrafted Vinifera varieties growing on their own roots.

Some stocks are better suited for bench grafting; others for vineyard grafting.

The relative rooting qualities of resistants are an important consideration in the cost of establishing resistant vineyards.

Species hard to grow from cuttings can be grown from seed, but seedlings vary greatly, and for this reason are undesirable for commercial vineyard purposes.

Cuttings of many hybrids root easily, although the cuttings from one of the parents are hard to root.

Many hybrids are deficient in one or more of the essential qualities of their parents, while in others a majority of the desirable qualities of both parents are combined. When all the qualities desired can not be found in two varieties, if found in three or more, complex hybrids from these may yield the desired results.

Cuttings of Monticola, Berlandieri, Aestivalis, Linsecomii, Bicolor, and Candicans are hard to root. They should therefore be rooted in a nursery and either grafted there or planted in the vineyard and grafted.

Riparia varieties root easily from cuttings, are excellent stocks, and do well when either vineyard or bench grafted, but there are few California soils suited to them. Soils in which Riparia varieties thrive usually produce large crops of only fair quality.

Rupestris varieties are well adapted for bench grafting, and then the dormant eyes should be cut out of the stock. Rupestris varieties root easily from cuttings and graft well, but the congeniality of many Rupestris with Vinifera varieties is low and the time of ripening the fruit is retarded.

The congeniality between Riparia, Berlandieri, and Champini stocks with Vinifera varieties is in most instances good, and the fruitfulness of the Vinifera on them is usually increased and the time of ripening hastened.

Hybrids between Riparia and Rupestris varieties will probably prove to be among the stocks best suited for California conditions, the best of them combining in themselves the better qualities of both parents.

Every intending grape grower (1) should be thoroughly informed on what Vinifera variety or varieties he desires to grow and whether they are suited to the locality in which they are to be grown; (2) he should ascertain the varieties of resistant stocks suited to his soil and location, and where several varieties are equally suited (all other things being equal), the most phylloxera-resistant ones which are the most congenial stock for the Vinifera variety he intends to grow should be selected; (3) he should determine beforehand whether bench or nursery grafts are to be used or whether he intends to establish the stocks in the vineyard (the suitability of stocks in this respect varying decidedly) and graft afterwards; (4) he should be familiar with bench, nursery, and vineyard grafting and with all the different operations required in establishing resistant vineyards.

PLATES.

DESCRIPTION OF PLATES.

Frontispiece.—Map of California, showing the location of the eleven experiment vineyards of the Bureau of Plant Industry.

Plate I. Fig. 1.—A Vinifera or nonresistant vineyard, showing vines in different stages of decline resulting from the attacks of phylloxera on the roots, the vacancies indicating where the vines have already died. Fig. 2.—A Vinifera vineyard being destroyed by the California vine disease, the three rows in the center in which the vines are nearly dead being one variety, whereas the two other varieties, one on either side, are in a fairly vigorous condition. These have also died since. Fig. 3.—A Vinifera nonresistant vineyard dying from the effects of exceptionally dry seasons, phylloxera, California vine disease, and other causes.

Plate II. Illustrations of habits of the root systems of different species. (1) *Vitis champini;* a fleshy root system. (2) *Vitis vulpina*, formerly called Riparia; a spreading root system. (3) *Vitis rupestris;* a deep-striking root system. (4) Rupestris × Berlandieri, No. 301–37–152; a hybrid between *Vitis rupestris*, which has a deep-striking root system, and *Vitis berlandieri*, which has a rather spreading root system, the hybrid having an oblique root system.

Plate III. Typical California vineyards in characteristic locations. Fig. 1.—A young vineyard in the desert of San Bernardino County. Fig. 2.—A vineyard in Fresno County, in the San Joaquin Valley. Fig. 3.—A vineyard on rolling sidehills in Sonoma County.

Plate IV. Fig. 1.—A Vinifera variety grafted on resistant stock (Mission on Lenoir) to resist the phylloxera. Fig. 2.—A direct producer (Hybrid Seibel, No. 1), which resists the phylloxera, and is therefore grown on its own roots.

Plate V. Fig. 1.—A Vinifera grafted on resistant stock, showing roots growing from the Vinifera graft, which, if not removed, will have a tendency to replace the resistant stock underneath. Fig. 2.—The same vine shown in figure 1, with the roots from the graft removed, as they should be. Fig. 3.—Phylloxera being placed on the roots of vines in one of the experiment vineyards for the purpose of testing their resistance to phylloxera attacks. Fig. 4.—A strong-growing Vinifera variety grafted on a less-vigorous resistant stock, the junction being where the enlargement on the trunk occurs. Fig. 5.—A Vinifera variety grafted on a resistant of like vigor; the union is so complete that the junction is hardly visible. Fig. 6.—Scientific investigator examining vines and taking notes on them and their environments and the effects these environments have on the vines.

Plate VI. Fig. 1.—A vine just grafted in the vineyard and covered with earth to protect the scion and keep it from drying out until it is established on the stock, the tools shown being those necessary to perform this operation. Fig. 2.—A vine just grafted and ready for covering. Fig. 3.—Vinifera varieties bench-grafted on resistant cuttings, rooted in nursery, packed for shipment from France to the United States.

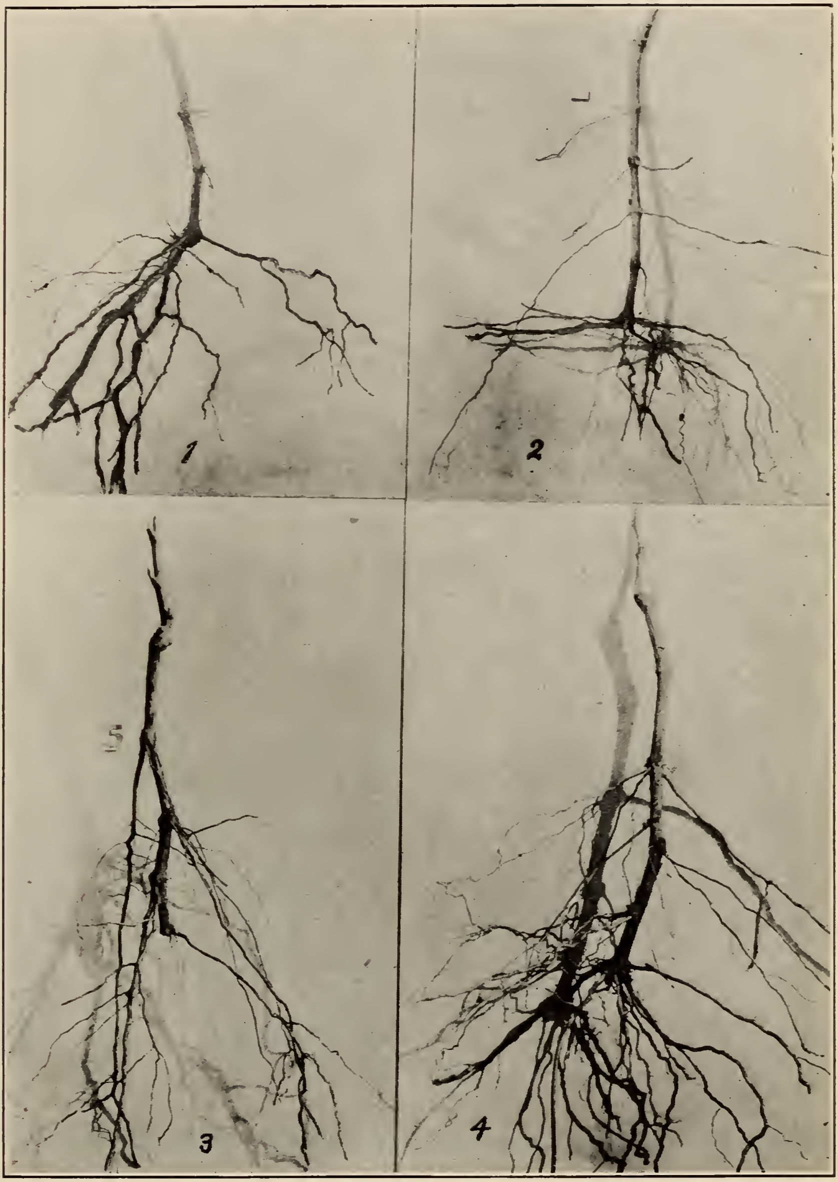
Plate VII. Fig. 1.—Vinifera varieties bench-grafted on resistant stock, rooted, and growing in nursery for vineyard planting. Fig. 2.—A portion of the Oakville experiment vineyard just after grafting and covering. Fig. 3.—The same grafts shown in figure 2 one year old, just after pruning and tying to stakes.

Plate VIII. Leaves of six hybrids originated in France and extensively used as stocks on which to graft Vinifera varieties. *A*, Leaf of Mourvedre × Rupestris, No. 1202. A cross between a Vinifera and a Rupestris originated by Couderc. *B*, Leaf of Riparia × Rupestris, No. 101. A cross between a Riparia and a Rupestris originated by Millardet. *C*, Leaf of Riparia × Rupestris, No. 3309. A cross between Riparia and Rupestris originated by Couderc. *D*, Leaf of Riparia × Rupestris, No. 3306. A cross between Riparia and Rupestris originated by Couderc. *E*, Leaf of Berlandieri × Riparia, No. 420A. A cross between Riparia and Berlandieri originated by Millardet. *F*, Leaf of Riparia × (Cordifolia × Rupestris), No. 106–8, originated by Millardet and de Grasset.

FIG. 1.—VINEYARD PARTLY DESTROYED BY PHYLLOXERA.

FIG. 2.—VINEYARD PARTLY DESTROYED BY CALIFORNIA VINE DISEASE.

FIG. 3.—VINEYARD PARTLY DESTROYED BY DIVERSE AGENCIES.



VARIOUS TYPES OF ROOT SYSTEMS OF GRAPEVINES: (1) A FLESHY ROOT SYSTEM; (2) A SHALLOW OR SPREADING ROOT SYSTEM; (3) A DEEP-STRIKING ROOT SYSTEM; (4) AN OBLIQUE ROOT SYSTEM.

FIG. 1.—A VINEYARD IN A DESERT.

FIG. 2.—A VINEYARD IN A VALLEY.

FIG. 3.—A VINEYARD ON A HILLSIDE.

FIG. 1.—A VINIFERA GRAFTED ON RESISTANT STOCK.

(Mission on Lenoir.)

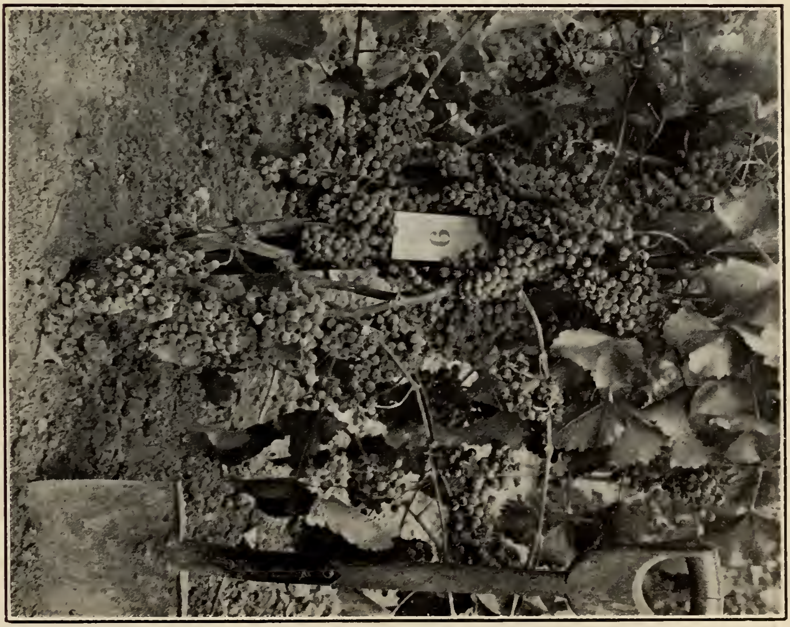


FIG. 2.—A DIRECT PRODUCER.

(Seibel, No. 2.)

FIG. 1.—A GRAFT WITH ROOTS GROWING FROM THE SCION. FIG. 2.—THE SAME VINE SHOWN IN FIGURE 1, WITH ROOTS REMOVED, AS THEY SHOULD BE. FIG. 3.—PHYLLOXERA BEING PLACED ON ROOTS OF VINE TO TEST RESISTANCE. FIG. 4.—A STRONG-GROWING TYPE GRAFTED ON A WEAKER GROWING STOCK. FIG. 5.—GRAFT AND STOCK OF THE SAME RELATIVE GROWTH. FIG. 6.—SCIENTIFIC INVESTIGATOR EXAMINING VINES AND TAKING NOTES IN AN EXPERIMENT VINEYARD.

FIG. 1.—A VINE GRAFTED AND COVERED UP AND TOOLS USED IN GRAFTING. FIG. 2.—A VINE JUST GRAFTED AND NOT YET COVERED. FIG. 3.—GRAFTED VINES PACKED READY FOR SHIPMENT FROM FRANCE.

FIG. 1.—A GRAPE NURSERY.

FIG. 2.—A RESISTANT EXPERIMENT VINEYARD JUST GRAFTED.

FIG. 3.—A RESISTANT VINEYARD WITH GRAFTS ONE YEAR OLD.

LEAVES OF SIX HYBRIDS ORIGINATED IN FRANCE AND EXTENSIVELY USED AS STOCKS ON WHICH TO GRAFT VINIFERA VARIETIES.

A, Leaf of Mourvedre × Rupestris, No. 1202 (about five-sixteenths natural size); *B*, leaf of Riparia × Rupestris, No. 101 (about five-fourteenths natural size); *C*, leaf of Riparia × Rupestris, No. 3309 (about five-thirteenths natural size); *D*, leaf of Riparia × Rupestris, No. 3306 (five-sixteenths natural size); *E*, leaf of Riparia × Berlandieri, No. 420 A (five-fourteenths natural size); *F*, leaf of Riparia × Cordifolia × Rupestris, No. 106–8 (about five-fourteenths natural size).

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